Oyster Stock Assessment Report

Of the Public Oyster Seed Areas of Louisiana
Seed grounds and Seed Reservations

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Introduction

The oyster resource in Louisiana is one of the largest and most valuable in the nation. Its value is derived from both the economic benefits it provides to the state and the ecological benefits it provides to the estuarine environment. Due to Louisiana's vast coastal wetland area, ample habitat exists where oysters thrive under a variety of environmental conditions. The Department of Wildlife and Fisheries (LDWF) is charged with managing the oyster resource on the public grounds by closely monitoring the size and health of oysters on nearly 1.7 million acres of public water bottoms (see map on page xiii). Oyster management on these public grounds includes activities such as setting oyster seasons, monitoring harvest levels, and habitat enhancement (i.e. cultch planting, reef building) projects.

Typically, the oyster industry utilizes the public oyster grounds as a source of seed oysters (< 3") for transplant to private leases. The public grounds also yield a supply of sack-sized oysters (≥ 3") and these oysters may be taken directly to market. The manner in which both the public grounds and private leases are utilized in combination helps to keep Louisiana's industry as a national leader in oyster production with annual value typically in excess of $35 million worth of dockside sales.

Oysters also play an important ecological role in the estuarine ecosystem. Oyster reefs provide the majority of hard substrate required by other sessile invertebrate species such as barnacles, bryozoans, tunicates, and anemones. Reefs are also utilized as shelter and forage habitat for many species of crabs, worms, fish, and meiofauna. Estuarine water quality can be enhanced by the filter-feeding activities of oysters, and reefs may also play a role in stabilizing shorelines.

Louisiana Oyster Landings

Oysters have been a part of the Louisiana economy for many years and support a multi-million dollar industry. Louisiana regularly leads the nation in the production of oysters and accounted for an average of 34% of the nation's oyster landings over the 1997 – 2011 time period (Figure 1). After depressed oyster (*Crassostrea virginica)* landings in 2010 totaling under 7 million pounds, Louisiana rebounded to 11.1 million pounds in 2011 (NMFS data) and 10.9 million pounds in 2012 (preliminary LDWF data). Among Gulf of Mexico states, Louisiana consistently ranks #1 in landings and accounted for nearly 60% of all oysters landed in the region in 2011[1].

The public oyster grounds can be considered the backbone of the Louisiana oyster resource. These grounds are a valuable contributor to overall Louisiana oyster landings each year, while also supplying seed oysters transplanted to private leases for grow-out purposes. The trend from 1970 – 1992 showed the majority of Louisiana oyster landings came from private reefs. From 1992 to 2001, however, the public ground stock size increased, in general, and landings from the public grounds increased as well. In 2008, harvest levels significantly increased on the public grounds over 2007 levels and the public grounds produced approximately 47% of all oyster

[1] Finalized state-by-state landings for 2012 were not available from the National Marine Fisheries Service (NMFS) at the time of this publication, so data comparisons between Louisiana and other states were not possible.

landings for the calendar year. This reliance on the public grounds reversed during the 2009-2012 time period and preliminary harvest data showed that 96% of all oysters landed in Louisiana came from private leases in 2012 (Figure 2).

When comparing the price per pound of oyster meat on public grounds and private leases, public ground oysters oftentimes command higher prices than oysters harvested from private leases. In 2012, public ground oysters fetched $4.47 per pound at the dock while private lease oysters commanded considerably less at $3.69 per pound. Overall average price per pound for all Louisiana oysters in 2012 was $3.72, a small $0.02 decreased from 2011, according to preliminary LDWF Trip-Ticket data. This increase in the value of public ground oysters at the dockside may be related to a continued lack of oyster supply, and that oysters are typically harvested from these areas during times in which oyster market demand is high. Nationwide 2012 landings data from the National Marine Fisheries Service (NMFS) were not available during the time period covered by this report. Therefore, preliminary 2012 Louisiana oyster landings data cannot be compared to national landings.

<u>Statewide Oyster Stock Assessment Overview</u>

Methods

During the summer, LDWF biologists from each Coastal Study Area (CSA) of the Fisheries Division perform quantitative evaluation of the oyster resource on the public oyster areas (Figure 3). This biological evaluation includes using SCUBA to collect oyster samples from within a square meter frame from multiple locations (sample stations) in each public oyster ground. At each station, five replicate square-meter samples are collected and data is combined to produce average numbers of spat, seed, and sack oysters per station. Spat are young oysters measuring one to 24 millimeters (mm) in length. Seed oysters measure 25 to 74 mm and sack (= market-size) measure 75 mm and above. The numbers of oysters per station is then multiplied by the reef acreage to obtain an estimate of the total oysters present on the reefs. Sampling undertaken as part of the annual stock assessment plays a valuable role in predicting the success of the upcoming oyster season, which generally opens in early September and runs through April of the following year (although the season may be closed or delayed if biological concerns or enforcement problems are encountered). This stock size information is used to make recommendations to the Wildlife and Fisheries Commission for the setting of the oyster season.

A total of 106 sample stations were visited by LDWF biologists during the 2013 assessment and 530 individual samples were gathered. Information gathered from sampling is divided into the respective CSAs and data are presented by CSA. Coastal Study Area 1 South holds the most sample stations (33) while CSA 5 East holds the fewest (3). A higher density of sampling occurs in the Black Bay (CSA 1 South) and Sister Lake (CSA 5 West) areas due to their high level of oyster production in past years and increased historical importance to the oyster industry.

Annual Stock Size

The statewide oyster stock size in 2013 has increased over 2012 levels as approximately 1,707,255 (±262,598) barrels of oysters are available on the public oyster areas of Louisiana this year (Table 1). Although this stock size represent an approximate increase of 38% from 2012 levels, statistical comparisons of the two estimates show no significant statistical difference. The 2013 statewide stock availability is once again largely influenced by oyster stocks in Calcasieu and Sabine Lakes (CSA 7), but still remains approximately 50% below the long-term mean of 3.4 million barrels (Figure 4)[2]. If the Sabine Lake oyster stock is removed from the 2013 and long-term calculations of statewide oyster availability, the 2013 statewide oyster stock size is 71% below the long-term mean. The overall increase was also driven by a large increase in seed oyster stocks. Statewide seed oyster availability increased approximately 95% as compared to 2012 levels, while market-size availability fell 0.4% (Figure 5). The stock size estimate is based on reef acreage updates performed in 2013 based on recent side-scan sonar water bottom surveys (see below for additional information).

Table 1. Estimated Statewide oyster stock size on the public oyster areas of Louisiana. CSA denotes Coastal Study Area. Percentage columns (%) indicate percent of statewide total. Data in barrels and 1 barrel = 2 sacks.

CSA	Seed	Seed %	Sack	Sack %	Total	Total %
1N	425,896	43.5%	24,753	3.4%	450,649	26.4%
1S	282,332	28.8%	18,587	2.6%	300,919	17.6%
3	16,507	1.7%	5,897	0.8%	22,404	1.3%
5E	190	0.0%	440	0.1%	630	0.0%
5W	27,249	2.8%	38,047	5.2%	65,297	3.8%
7	227,360	23.2%	639,997	87.9%	867,357	50.8%
Total	***979,534***		***727,721***		***1,707,255***	

The historic primary public grounds east of the Mississippi River showed overall gain in oyster availability in 2013 as compared to 2012. Positive signs were noted in CSA 1-North where an approximate 124% increase in oyster stocks was estimated from biological sampling. This increase was driven largely by significant gains in seed oyster stocks which rose 259% to 425,896 (±46,765) barrels, more than off-setting a 70% decline in market-size oyster abundance. Of total seed oyster availability in CSA 1-North, however, approximately 338,000 barrels is located on the 2011 Round Island cultch plant (291 acres). After a historic low in seed oyster availability in CSA 1-South in 2012, large gains were made in this oyster size class as stocks climbed approximately 5,336% to 282,332 (±119,307) barrels of seed. Public reefs in this area, however, showed troubling decreases in market-size oyster stock abundance, falling approximately 31% to its lowest point since 1991.

In public grounds west of the Mississippi River through the Vermilion Bay area, the general trend was decreasing oyster stocks. The only increase was found in Coastal Study Area 3 where seed oyster stock rose 57% to 16,507 (±3,253) barrels. Results from square-meter sampling in Sister Lake (CSA 5 West) indicated a continued decrease in oyster availability as stocks dropped nearly 30% to 65,297 (±35,950) barrels.

Only a slight decrease in overall oyster stocks was documented in CSA 7 as both Calcasieu and Sabine Lake saw decreases in seed oysters during 2013 sampling. Despite the drop in CSA 7 seed oyster availability, a sizeable increase in market-size oysters in Sabine Lake to 639,997 (±83,470) barrels was found. The east side of Calcasieu Lake is estimated to hold no live seed or market-size oysters for the second consecutive year and oyster resources in the west cove portion of Calcasieu Lake dropped from 160,805 (±85,187) barrels in 2012 to 114,275 (±58,726) barrels

[2] Oyster stocks in Sabine Lake have only been assessed from 2010 to present, and are, therefore, only included in statewide totals since 2010.

in 2013. Despite the slight decrease, CSA 7 continues to contribute the most animals towards the annual stock assessment (Table 1; Figure 6).

Factors Affecting the 2012 Oyster Stock Assessment

A variety of factors, both natural and anthropogenic, affect the oyster stock size on the public grounds in any given year. Natural threats to oyster survival include extreme low salinities caused by high river discharge and localized rainfall, as well as predation and disease typically associated with periods of high salinity and high temperature. Construction activities (e.g. oil and gas production), harvest and environmental perturbations (e.g. hurricanes) can also impact oyster abundance.

A significant event which is suspected of having continued impacts on a large portion of the coastline and oyster resources was the *Deepwater Horizon* oil spill of 2010. Extensive reductions in oyster recruitment have occurred since 2010, with the timing of such coincidental to the oil spill. Research is ongoing into the possible impacts of oil, dispersant, and freshwater releases to Louisiana's near shore environment, including to oysters and oyster habitat.

Environmental Conditions

Scientific research indicates that reproduction of oysters becomes limited as salinities drop below seven parts per thousand (ppt). Additionally, salinities below five ppt coupled with water temperatures above 23^o Celsius has been documented to cause significant oyster mortalities. As depressed salinities continue into the hotter summertime months, physiological stress on oysters increases and mortalities can occur. This is a somewhat regular occurrence in areas such as the Vermilion Bay system (CSA 6), but can also occur periodically in other areas of Louisiana's public oyster grounds.

Low salinity conditions occurred again in parts of the Louisiana coastline during critical reproductive time periods in the spring and early summer of 2013. Coastal Study Area 6 experienced extended periods of salinity below five ppt during May and June, and biological sampling (dredge) in late June found oyster mortalities in excess of 60%. In early June, catch per unit effort (CPUE) from biological sampling (dredge) indicated 17.7 seed oysters per dredge sample, but the seed-oyster CPUE dropped to 6.0 in late June and to 0.3 during the annual oyster stock assessment sampling in July.

"Optimal" salinity conditions for seed-oyster production on the public oyster seed grounds east of the Mississippi River have been described by Chatry et al (1983)[3]. As oyster abundance has declined in recent years east of the Mississippi River, a comparison of 2000-2013 salinity conditions in this area to the Chatry "optimal" salinity was undertaken. Average monthly salinities in CSA 1-South were well below these optimal levels during the months of May and June 2013 with salinity deviations from "optimal" of -2.02 and -5.82 parts per thousand (ppt), respectively. Overall, however, the average salinity deviation for the 12-month period preceding the 2013 oyster stock assessment was only -0.06 ppt. This is in stark contrast to some previous years (12 months preceding the annual stock assessment) during the 2000-2013 time series where average monthly salinity deviations have exceeded 3.0 ppt (Figure 7).

[3] Chatry, M., R. J. Dugas, and K. A. Easley. 1983. Optimum salinity regime for oyster production on Louisiana's state seed grounds. *Contributions in Marine Science*. 26:81-94.

To further investigate the relationship between salinity and decreasing oyster abundance, a simple linear regression (SLR) analysis was performed comparing salinity deviations against the change in seed oyster stock size. Salinity deviations were determined using U.S. Geological Survey information from the data collection platform (DCP) location in Black Bay near Snake Island. This DCP provides salinity values every half-hour, and those data were utilized to calculate an average salinity each month for each year. The monthly averages were compared to the corresponding monthly "optimal" salinity as described by Chatry et al (1983), and salinity deviation for each month was determined. Monthly deviations were averaged for each year ("Year" = the 12 months prior to the annual stock assessment), and the annual average salinity deviation was compared to the change in seed oyster abundance. The change in seed oyster abundance was calculated as the difference between one year's seed abundance and the previous year's seed abundance.

The SLR analysis of salinity deviation versus change in seed oyster abundance indicated a strong relationship between salinity deviations and the change in seed oyster stock size from one year to the next. The regression model for the 2000-2013 time series was statistically significant ($P<0.003$) and suggested that salinity deviations during those years explained roughly 53% of the variability in seed oyster abundance ($R^2=0.53269$). Furthermore, in 3 of the 4 years where a positive salinity deviation occurred (indicating higher salinity than what Chatry described as "optimal") during the time series, seed oyster abundance increased. Conversely, in 8 of the 10 years in which salinity deviations were negative (indicating lower salinity), seed oyster abundance decreased (Figure 8). Although the regression analysis suggests a linear relationship between the two variables (salinity and seed oyster abundance) for this time series, additional data likely would begin to show a different relationship. It is likely that at very high positive salinity deviations (very high salinities), seed oyster abundance decreases due to increases in predation and disease forces. Therefore, the true relationship between the two variables is likely parabolic (bell-shaped) and not linear.

Table 2. Harvest estimates for the 2012/2013 oyster season on the public oyster grounds of Louisiana. Data derived from fisheries dependent surveys of harvesting vessels (=boarding reports) and not from LDWF Trip-Ticket data (except CSA 7). Percentages indicate the change from the previous season. 1 barrel = 2 sacks.

CSA	Seed Oysters (barrels)	Market Oysters (sacks)	Total (barrels)
1 North	2,540	3,519	4,300
1 South	0	5,586	2,793
3	2,517	5,151	5,093
5 East	0	1,059	530
5 West	1,075	3,406	2,779
6	375	7,226	3,988
7	0	38,950	19,475
Total	***6,507 (-88%)***	***64,897 (-71.6%)***	***38,958***

Salinities in many areas of the Louisiana coast were likely heavily influenced by Mississippi River discharge, especially in areas such as CSA 1-South and CSA 3. Hydrographs of river discharge during the 12-month period preceding the 2013 oyster stock assessment indicates higher-than-average discharge rates for March through June 2013 (Figure 9), coinciding with the springtime period of oyster reproduction and recruitment.

Oyster Reproduction and Larval Recruitment
The ability of a species to produce successful offspring is critical to long-term sustainability of the population. Oysters are broadcast spawners, and release millions of gametes (eggs and sperm) into the water column when environmental conditions are conducive to reproduction. This reproductive activity typically peaks in coastal Louisiana, cued mainly by water temperature changes, in the spring and fall of each year.

LDWF biological sampling since the spring of 2010 continues to show troubling indications of reproductive failures in some areas. Successful spat sets (the settlement of oyster larvae onto a suitable surface and the metamorphosis of those larvae into baby oysters, called spat) have been noted in some areas, while CSA 1 South has not had a widespread successful spat set event since the fall of 2009. This area experienced very little spatfall in the spring and fall of both 2010 and 2011. Only three sample sites showed spat during the 2012 oyster stock assessment and very few spat were found during the 2013 oyster stock assessment. This poor larval recruitment success over the recent years may be due to a variety of factors, yet the timing is coincidental to the occurrence of the *Deepwater Horizon* oil spill and response efforts.

Reproductive success oftentimes varies greatly from one area to another. Spat found in 2013 oyster stock assessment sampling showed such variation among the CSAs as evidenced by spat-to-oyster ratios (Figure 9). Although greater than one spat per adult was located in samples from CSAs 1-North and the Lake Chien/Felicity area, spatfall was overall low in the stock assessment samples. This data is highly dependent upon the number of animals collected in each size category, however, and should be evaluated alongside additional available data. For example, sampling in these two areas showed the highest spat-to-oyster ratios, yet overall catch-per-unit-effort (CPUE) of spat was relatively low yielding only 5.5 spat per sample in Lake Chien/Felicity and 4.3 in CSA 1-North. Poor reproductive success was noted in all other public oyster areas where less than one spat per oyster was found (Figure 10).

Tropical and Climatic Events
In late August 2012, Hurricane Isaac struck the central Louisiana coast as a Category 1 storm. Although the storm was considered a minor hurricane, the slow speed in which it moved through coastal Louisiana initially brought significant storm surge followed by a large amount of rainfall. Extensive coastal flooding was documented in communities such as Braithwaite, Louisiana (Plaquemines Parish east of MS River). Storm surge displaced waterbottom sediments and marsh vegetation, which were documented in the weeks following the storm on top of existing reefs in places such as Hackberry Bay (Jefferson/Lafourche Parish). Dredge sampling approximately two weeks post-storm in Hackberry Bay showed significant increases in oyster mortality to 29%. Similar increases also occurred east of the Mississippi River on public reefs (Plaquemines Parish) and in the Sister Lake Public Oyster Seed Reservation (Terrebonne Parish) where approximately 46% and 17% of oysters in samples were dead, respectively. In all cases, the majority of the overall oyster mortality was in the oyster spat size class (oysters < 1 inch). These animals represented seed oyster stocks that would have likely been available in the 2013 oyster stock assessment.

Commercial Harvest

Estimated commercial harvest fell sharply during the 2012/2013 oyster season (Table 2) as compared to the previous season and was likely the result of low market oyster abundance as reported by the 2012 oyster stock assessment. The 2012/2013 oyster season yielded less than 65,000 market sacks. CSA 1-South harvest dropped from approximately 65,000 barrels in 2011/2012 to just under 2,800 barrels in 2012/2013. A second-straight year of complete closure on the east side of Calcasieu Lake drove harvesters again to the west cove of Calcasieu. Strong harvest was again recorded in this area, however, as harvesters brought an estimated 38,950 sacks of market oysters to the docks (Table 2).

<u>Special Oyster Management Projects</u>

Over the past three years, LDWF biologists have participated in several important projects aimed at increasing oyster production on the public oyster seed grounds and reservations. Cultch planting is a reef rehabilitation method employed by LDWF since 1917 and was undertaken four times since last year's stock assessment and eight times since the fall of 2011. Additionally, LDWF again partnered with the Louisiana Sea Grant oyster hatchery on Grand Isle to provide hatchery-raised oyster larvae and spat to specific areas on the public grounds. Additional projects include shell-budget modeling, monitoring of reef removal during commercial harvest, and investigating fouling and disarticulation rates of oyster shells.

Cultch Planting

In direct response to oyster impacts from the Deepwater Horizon oil spill, four early restoration cultch plants were constructed during the past year. In the fall of 2012, approximately 20,000 cubic yards of limestone cultch material was spread over a 200-acre location in Bay Crab (Plaquemines Parish) and approximately 29,000 cubic yards of crushed concrete was deposited on a 300-acre site in Lake Fortuna (St. Bernard Parish). The following spring, Mississippi Sound near 3-Mile Pass (St. Bernard Parish) received approximately 40,000 cubic yards of limestone on a 158-acre project location and just over 18,000 cubic yards of limestone were spread over 200 acres of suitable water bottoms in Drum Bay (St. Bernard Parish) (Table 4). Biological sampling of these cultch plants during the 2013 oyster stock assessment yielded mostly disappointing results at these oyster rehabilitation locations. Although a successful spat set was documented on the Mississippi Sound location, almost no spat were collected in samples from the cultch plants in Drum Bay, Lake Fortuna, and Bay Crab.

As part of early restoration to address injuries to natural resources caused by the Deepwater Horizon oil spill, cultch material was also previously placed in Mississippi Sound (St. Bernard Parish) and California Bay (Plaquemines Parish) in the fall of 2011, and in Hackberry Bay (Lafourche Parish) and Sister Lake in May 2012. Biological sampling during the 2013 oyster stock assessment on these cultch plants showed indication of reef development. A large abundance of seed oysters were noted on the cultch plant in Mississippi Sound (known as the Round Island cultch plan) and some seed oyster were also found on the California Bay cultch plant. Unfortunately, the Hackberry Bay and Sister Lake samples showed very few oysters growing on these new cultch plants. Updates and monitoring information regarding the Deepwater Horizon Natural Resource Damage Assessment and early restoration projects will be posted at www.losco-dwh.com.

Hatchery-Raised Larvae and Spat

Oyster larvae and spat raised at the Louisiana Sea Grant bivalve hatchery on Grand Isle were again supplied to various public oyster areas as part of an extensive re-seeding effort in the late summer of 2012 and spring of 2013. The deployments of hatchery-raised animals should augment natural oyster stocks, although scientific testing of areas where young oysters were deployed in 2011 has proven inconclusive so far. Beginning in July 2012 and extending through June 2013, (the time period following the 2012 stock assessment sampling and prior to 2013 stock assessment sampling), over 367 million hatchery-produced oyster larvae and approximately 6.3 million spat were released in a variety of public oyster areas. All larvae and approximately 1/3 of the spat were released in the southeast area of Calcasieu Lake (Cameron Parish) where oyster abundance has drastically declined in recent years. Continued deployments of spat and larvae are planned for the coming year.

Sustainable Oyster Shellstock (SOS) Modeling

Under contract and through collaboration with LDWF, a research team led by Dr. Tom Soniat at the University of New Orleans (UNO) developed and tested a sustainable oyster shellstock (SOS) model for the public oyster areas of Louisiana. This computerized model provides guidance for fisheries management with the goal of conserving the oyster reef base. Oyster stock assessment sampling in 2012 provided model input data such as estimates of reef mass (grams per square-meter) and size-frequency of oysters. Utilizing additional data on oyster growth, mortality, and estimated commercial harvest rates, the model estimates the amount of oyster harvest that can be allowed while preserving the reef mass.

The UNO research team, LDWF representatives, and an oyster industry representative from the Louisiana Oyster Task Force met in late August 2012 to discuss the model simulations and results as part of the 1st annual Louisiana Stock Assessment Workshop (SAW 1). In general, the SAW felt that the model may prove to be a useful tool to help guide sustainable oyster harvest from Louisiana's public oyster areas, but that the model should be tested. It was decided to test the model advice in Hackberry Bay during the 2012/2013 oyster season. The model indicated that 3,500 barrels of seed and 4,700 sacks of market oysters could be harvested without detriment to the existing reef mass. Based on the model guidance, the oyster season was closely monitored and closed once these harvest thresholds were met. Although model guidance was produced for all other public oyster areas, the commercial harvest season in these areas was not modified accordingly.

The 2013 oyster stock assessment again provided data inputs for the SOS model and the 2nd annual Louisiana SAW was held to discuss model simulations and results. A thorough report on SAW 2 is included in a separate section of this document.

Reef Removal by Harvest Vessels

The removal of non-living reef material (cultch) by harvest vessels, especially vessels engaging in the harvest of seed oysters for bedding purposes, continues to be of concern to LDWF as it likely threatens the long-term sustainability of reefs on the public oyster seed grounds. This concern has been outlined in department correspondence at least as early as 1987. Departmental records indicate that staff biologists were concerned with the "apparent 'disappearance' of certain reefs in CSA II" and called for the elimination of "fishing shell" practiced by the commercial oyster industry. Subsequent LDWF records have continued to document this concern and estimates of cultch removal by vessels have been collected, when feasible, since the beginning of the 2006/2007 oyster season.

The sampling method was standardized across all CSAs at the beginning of the 2011/2012 oysters season (October 2011). Since sampling began in 2006, approximately 150 oyster vessels have been sampled with 52 samples coming over the past two harvest seasons. Standardized sampling involves randomly choosing bedding vessels and then collecting three random one cubic-foot samples of bedding material from the deck of the vessel. Those samples are then divided into that portion containing live oysters attached to reef material and that portion with no live oysters attached to the non-living reef material. A percentage of each group is then determined based on weight to the nearest one-tenth of a pound. Preliminary data analysis has indicated that, on average, bedding loads contain 23.8% non-living reef material. Preliminary analysis of only the data from the last two oyster seasons since standardized sampling methods were adopted indicates similar results of 25.0% on average, although figures as high as 94.7% have been documented.

Fouling and Disarticulation Studies

In the spring of 2013, CSA 7 biologists began a study in lower Calcasieu Lake to gather data on fouling and disarticulation rates of oysters through time. As oyster mortality estimates are important to stock size estimates and successful oyster management, accurately determining how long and oyster has been dead is necessary. Methods of estimating oyster mortality can vary and may include techniques such as counting boxes (box = two oyster valves gaped open, but still attached at the hinge), or counting "recent" dead (counting both boxes and single valves that appear to have died since the time of the previous sampling event). The LDWF oyster management program uses the "recent" dead method, but determinations of "recent" can sometimes be subjective. Therefore, the fouling study was developed to provide photographic examples of the appearance of the inside of oyster shells in a temporal context. The disarticulation portion of the study was developed to determine the temporal integrity of the oyster box (i.e. how long before a box breaks apart into separate valves).

Oysters are killed (as evidenced by gaping and unresponsive when probed) by exposing them to extreme salinities in the lab prior to the oyster box being affixed to the bottom of "Nestier" trays. Once the oyster boxes are affixed (14 boxes per tray), trays are deployed in the field at five locations (two trays per location) and then retrieved at certain time intervals. One tray per location is utilized for the fouling study and one tray is utilized for the disarticulation study.

For the fouling trays, the inside of the top valve of two boxes per tray are collected per sampling event. The valves are returned to the lab and evaluated for fouling organisms noting the type of fouling and approximate percent coverage of that type on the shell. The valves are then photographed, and photographs are being developed into an educational manual for oyster mortality determination. Evaluation of the disarticulation trays involves retrieving one tray per location during each sampling event and simply recording how many of the 12 boxes have broken apart into separate valves (disarticulated).

Preliminary data generated from these studies are being compiled and analyzed to provide guidance to future studies. The vast majority of fouling found on shells during each retrieval period was barnacles (*Balanus spp*) and a heavy set of barnacles was found on some shells after only seven days in the water. For the disarticulation study, a number of boxes disarticulated quickly (24% after 7 days), but disarticulation seemed to stabilize through time and was 29.2% at after 57 days. It is expected that these studies will be repeated in the fall of 2013 and the disarticulation trays will likely remain in the water until all boxes have disarticulated.

Update of Reef Acreage East of Mississippi River (CSA 1-North and CSA 1-South)
Based upon recent water bottom assessments utilizing side-scan sonar in 2010 and 2011, an extensive effort was completed to update reef acreage ('reef' refers to dense or scattered shell) on public grounds east of the Mississippi River. Historic reef acreage has been utilized for stock assessment calculations since the original water bottom assessments were performed in the mid-1970s. For CSA 1-North, recent water bottom assessments covered only a portion of the public oyster seed grounds. Therefore, reef acreage identified from areas assessed in 2010 was utilized in conjunction with historic acreage from areas not covered by recent water bottom assessments. Following this exercise, reef acreage was updated in CSA 1-North to 22,643 acres compared to the previous acreage figure of 21,308.

Water bottom assessments performed in 2011 in CSA 1-South covered the entire extent of known oyster habitat within this area. Therefore, all reef acreage identified in the 2011 assessments was available to fully replace the 1970s historic reef acreage. The 2011 water bottom assessments identified over 29,000 acres of oyster habitat and extensive analysis was undertaken to determine what portion of that acreage was accurately described (in terms of oyster abundance) by the 30 stock assessment sample sites in CSA 1-South. Following this analysis, it was determined that approximately 27,762 acres should be included in the stock assessment. Additionally, multiple sample sites were utilized in some instances to describe associated groups of reefs, referred to as a "reef complex." The result was an update to the CSA 1-South reef acreage from 16,644 acres based on the mid-1970s water bottom survey to 27,762.29 acres of reef based on the 2011 water bottom assessments. Additional information describing this project is contained within the area reports from CSA 1-North and CSA 1-South.

<u>Recent Legislation</u>
The 2013 regular legislative session included two bills filed with direct ties to oysters (Table 3). House Bill 345 was passed as Act 20 and extended the sunset date for the Public Oyster Seed Ground Vessel Permit requirement from November 15, 2013 to November 15, 2016. Commercial fishermen who wish to harvest oysters from a public oyster seed ground or reservation may only do so from a vessel which holds a valid Seed Ground Vessel Permit. House Bill 236 increased penalties for certain illegal oyster activity related to violations of the state sanitary code, taking oysters from a public oyster area during closed season, and other general oyster fishing violations.

Table 3. Summary of oyster-related legislation of the 2013 Louisiana regular legislative session.

Bill	Author(s)	Description	Passed?	Act
HB 236	Leopold	Increases penalties for certain oyster harvest violations	Yes	**35**
HB 345	Garofalo	Extends the sunset date for the Public Oyster Seed Ground Vessel Permit requirement to November 15, 2016	Yes	**20**

Conclusion and Acknowledgements

The following report includes both biological stock assessment and historical oyster landings data from each CSA in Louisiana, as well as a brief report on the most recent oyster season in each area. Biological data was generated from quantitative square-meter sampling (see above) and landings data was generated from field boarding runs and trip ticket information. Countless hours were spent by the field biologists of each CSA, both in gathering the samples and producing the report. Additionally (listed in alphabetical order), Harry Blanchet, Denise Kinsey, Brian Lezina, and Ty Lindsey greatly assisted with editorial review and preparation of this document. The efforts of both the field and office staff are greatly appreciated as this report could not be produced without the hard work and dedication of these many people. Questions and/or comments can be directed to Patrick Banks at 225.765.2370 or pbanks@wlf.louisiana.gov.

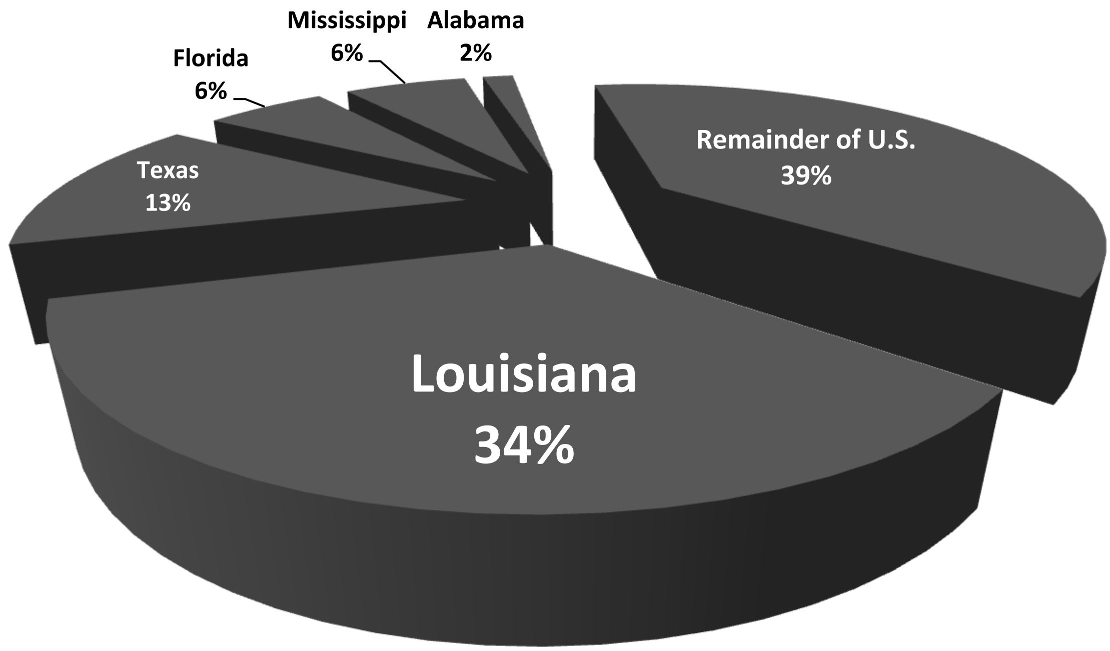


Figure 1. Percentage contribution to average annual landings of all oysters in the United States over the time period of 1997 through 2011. Data provided by National Marine Fisheries Service (NMFS).

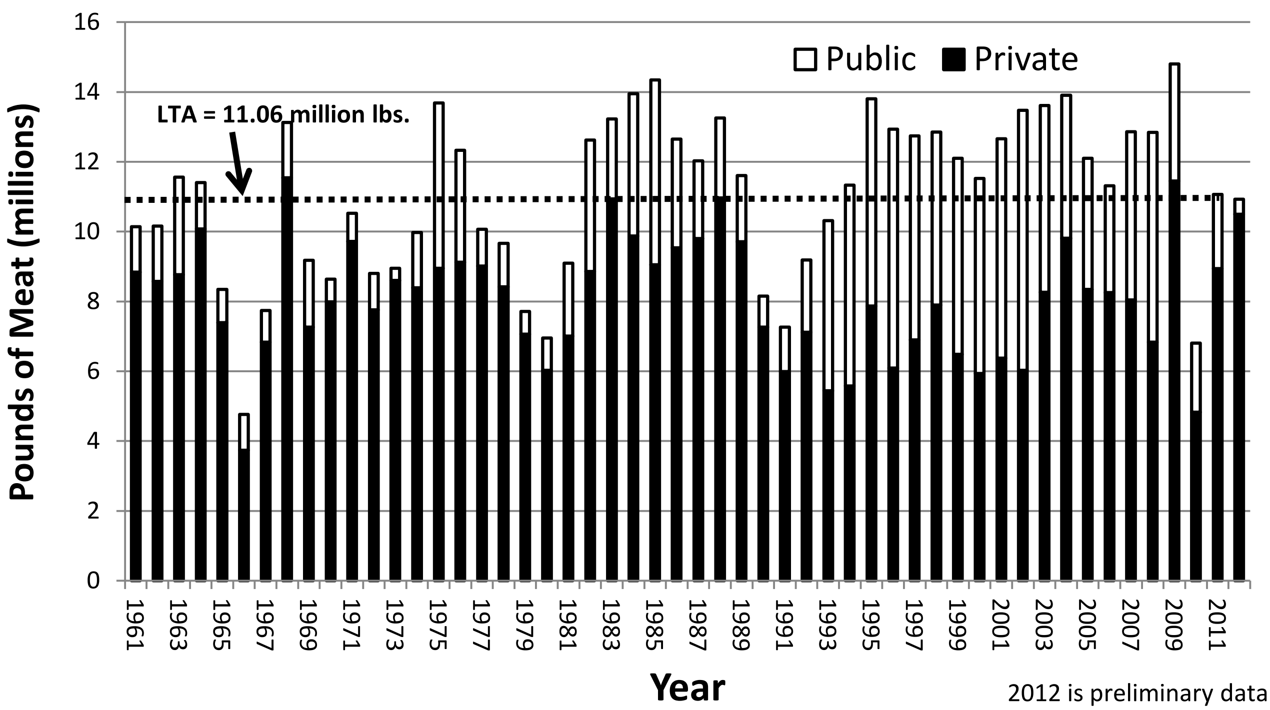


Figure 2. Historical Louisiana oyster landings for the public oyster areas and the private oyster leases (LDWF and NMFS data). 2012 harvest from private leases accounted for approximately 96% of the total.

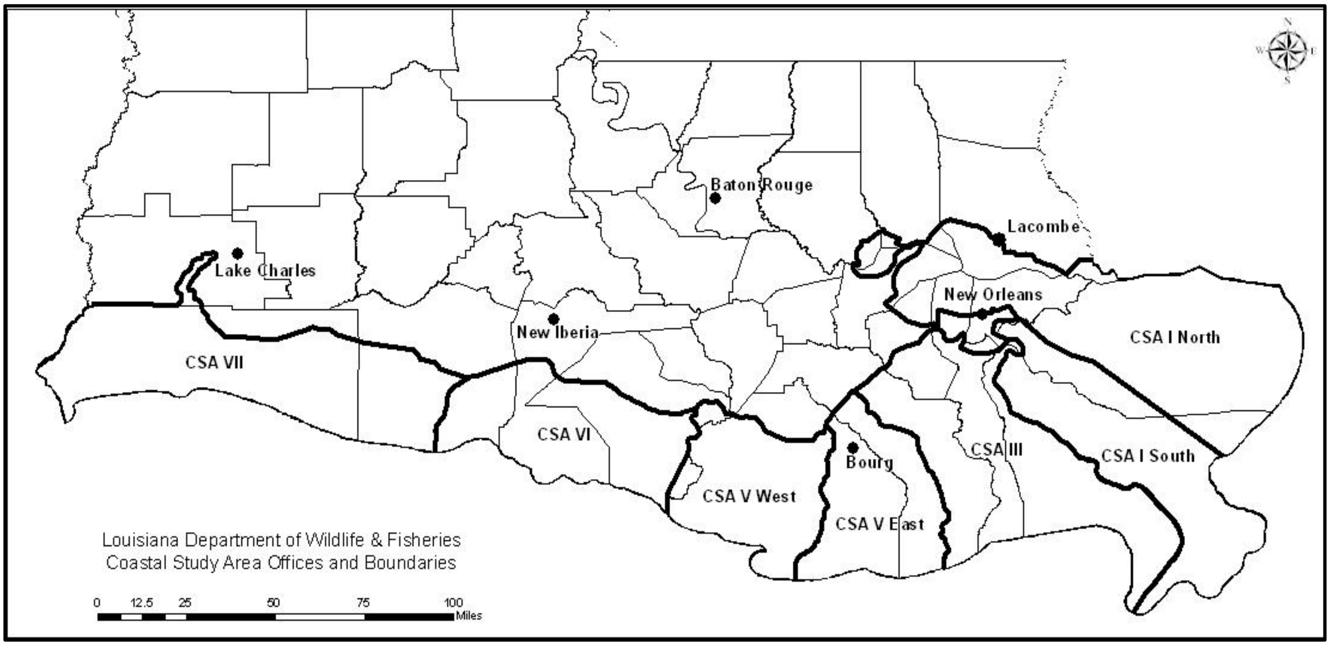
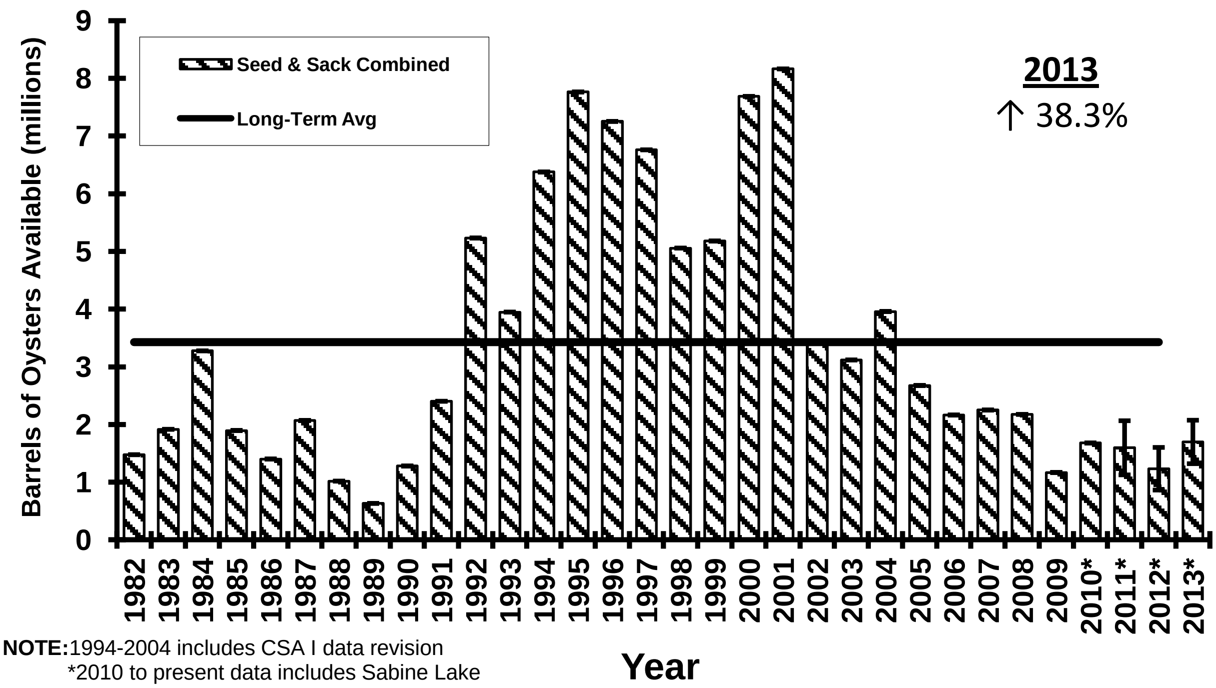


Figure 3. Map of LDWF Fisheries Division Coastal Study Areas (CSAs).



NOTE: 1994-2004 includes CSA I data revision
*2010 to present data includes Sabine Lake
Error bars denote standard error

Figure 4. Historical estimated oyster stock size on the public oyster areas of Louisiana. 1994 through 2004 data includes CSA 1N data revision. LTA denotes the long-term average of 1982 - 2012.

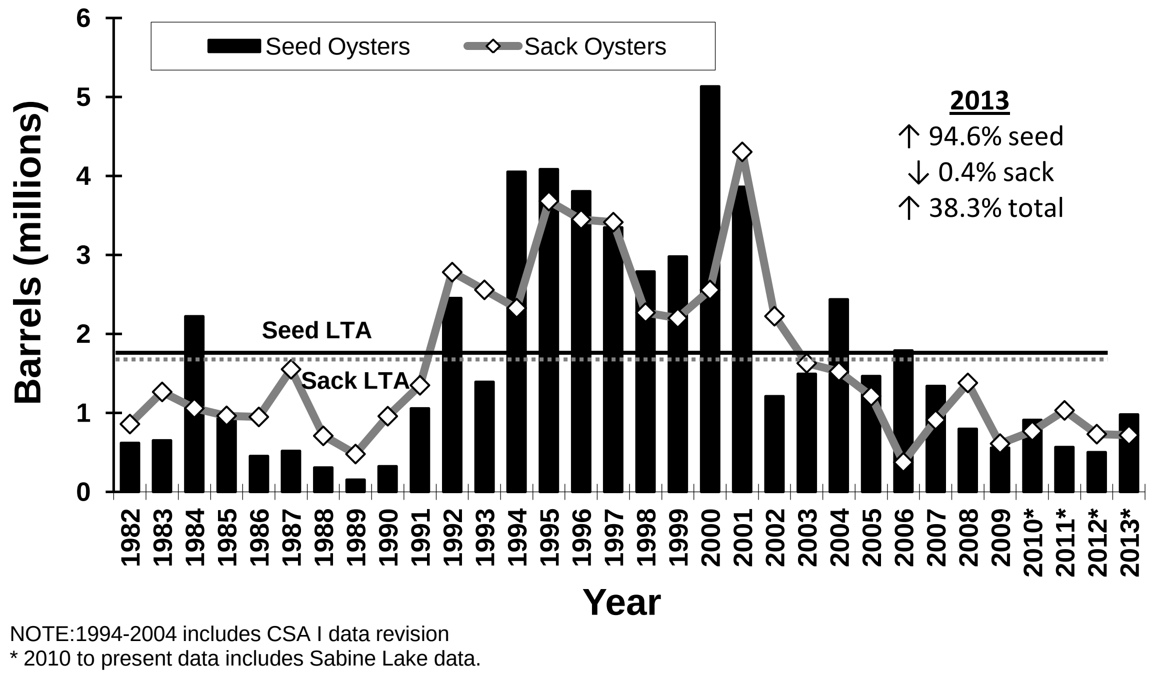


Figure 5. Historical Louisiana oyster stock size on the public oyster areas. LTA denotes the long-term average of 1982 - 2012.

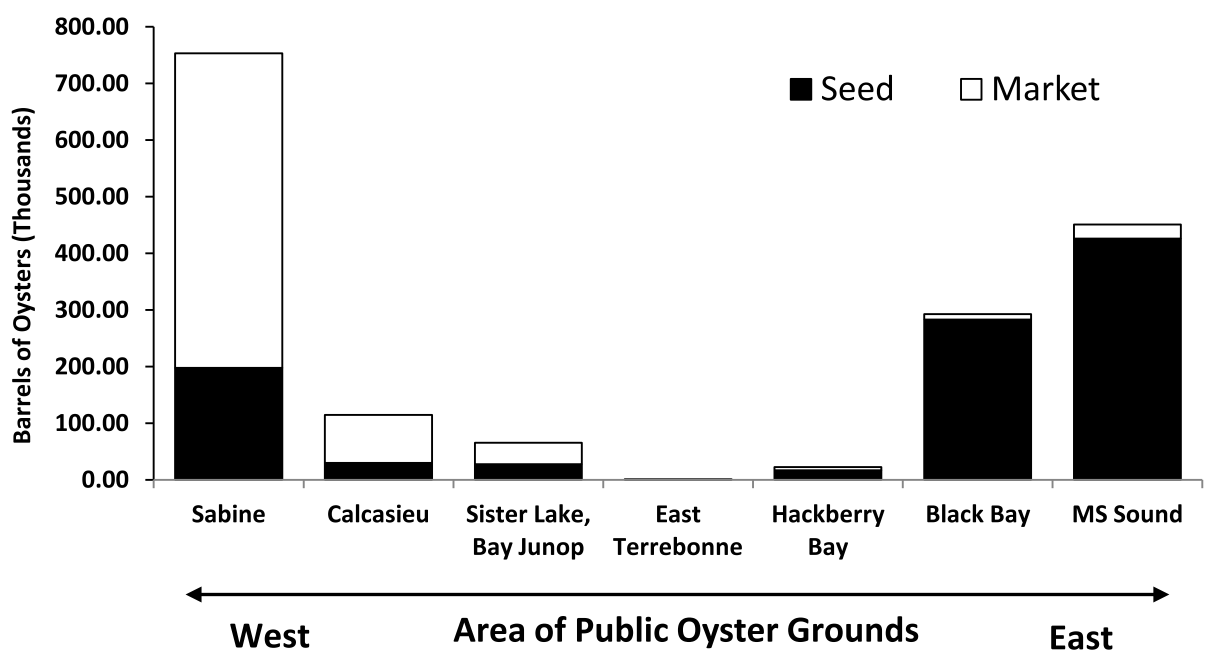


Figure 6. Statewide distribution of oyster stocks in the public oyster areas of Louisiana.

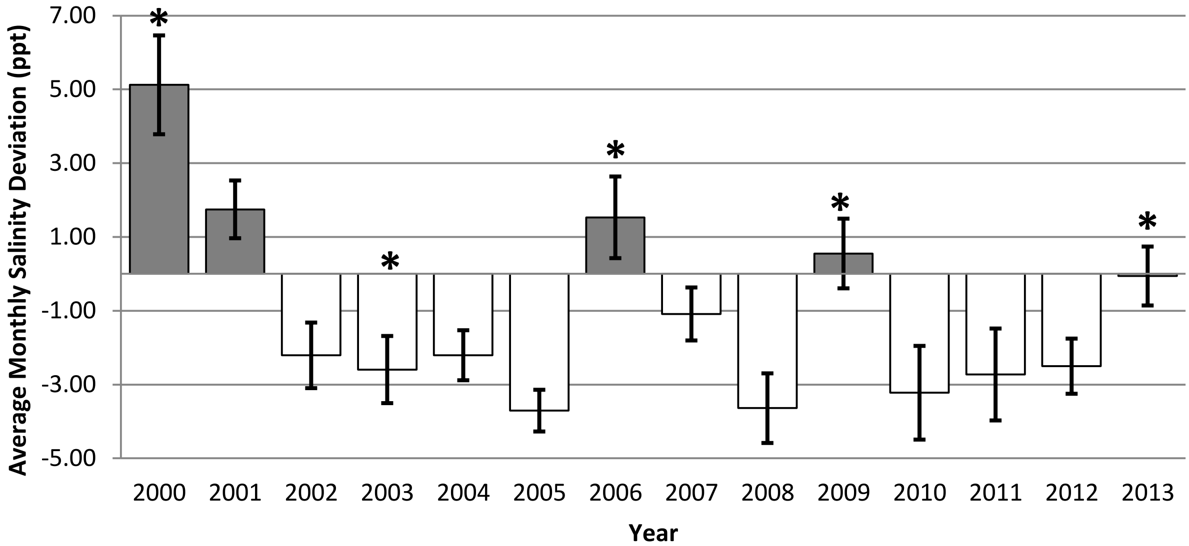


Figure 7. Average monthly salinity deviations (in parts per thousand) in Black Bay near Snake Island (Coastal Study Area 1-South). Grey bars represent the deviation from "optimal" salinity, as described by Chatry et al (1983), during the 12 months preceding the annual oyster stock assessment for that year. Asterisks (*) denote years in which seed oyster abundance increased over the previous year. Years without asterisks are those where seed oyster abundance decreased compared to the previous year. Error bars denote standard error of the monthly salinity deviation. (Data source: USGS)

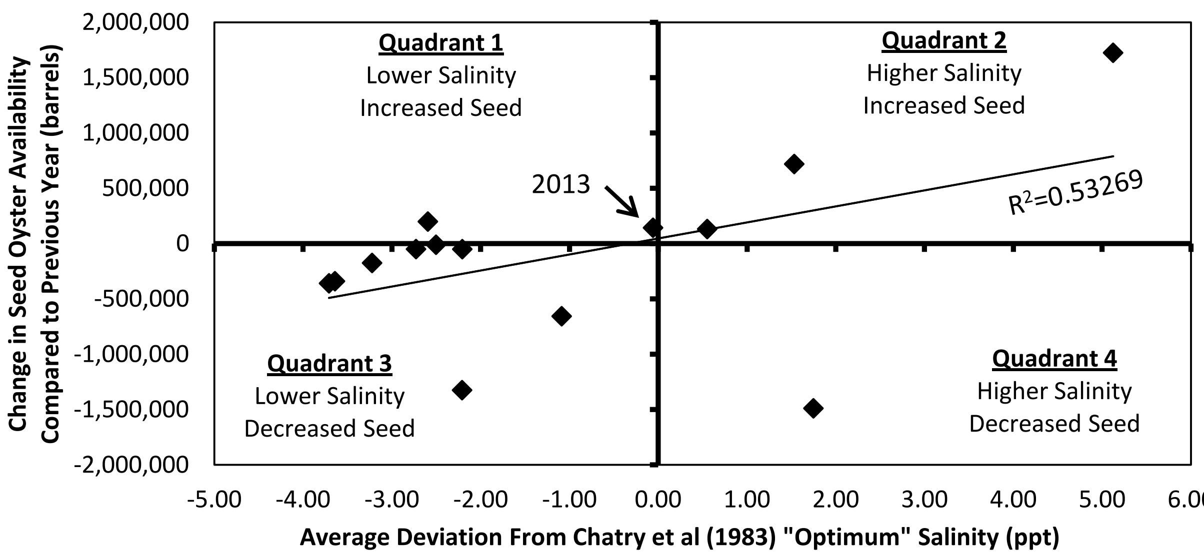


Figure 8. Scatter plot diagram showing annual salinity deviation against the corresponding change in annual seed oyster availability during the 2000-2013 time series in Coastal Study Area 1-South. The solid diagonal line indicates the positive relationship between the two variables as suggested by regression analysis.

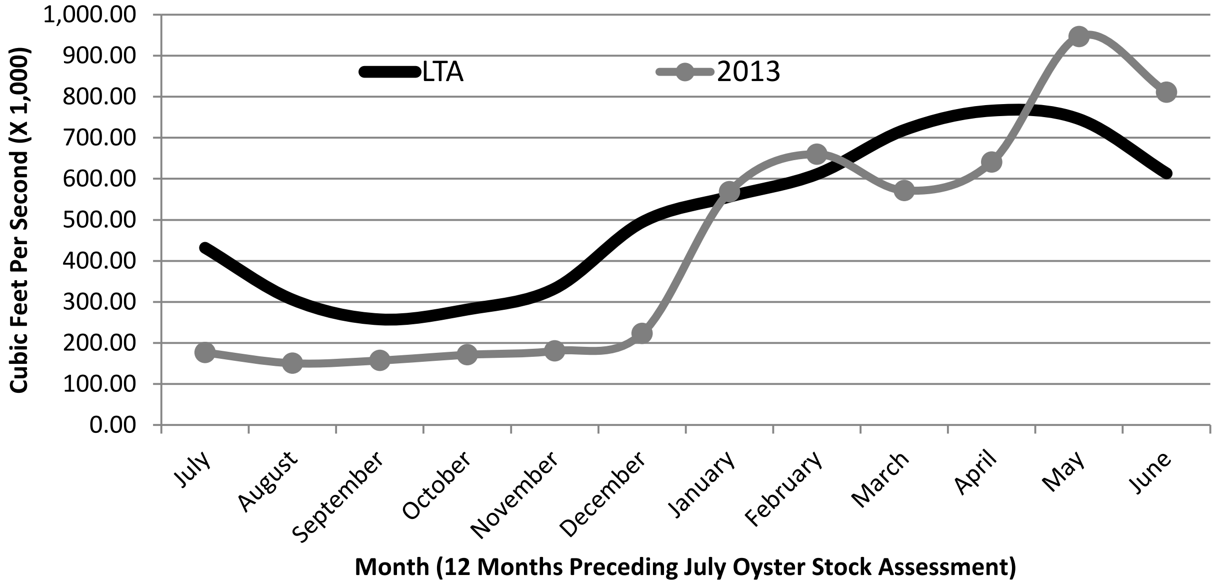


Figure 9. Average daily discharge per month of the Mississippi River at Talbert's Landing. LTA = long-term average of 1964-2012. Months indicate the months prior to the annual oyster stock assessment performed each July. For example, when referring to the 2013 line depicted in the figure, the months would reference July 2012 through June 2013. (Data source: USACE)

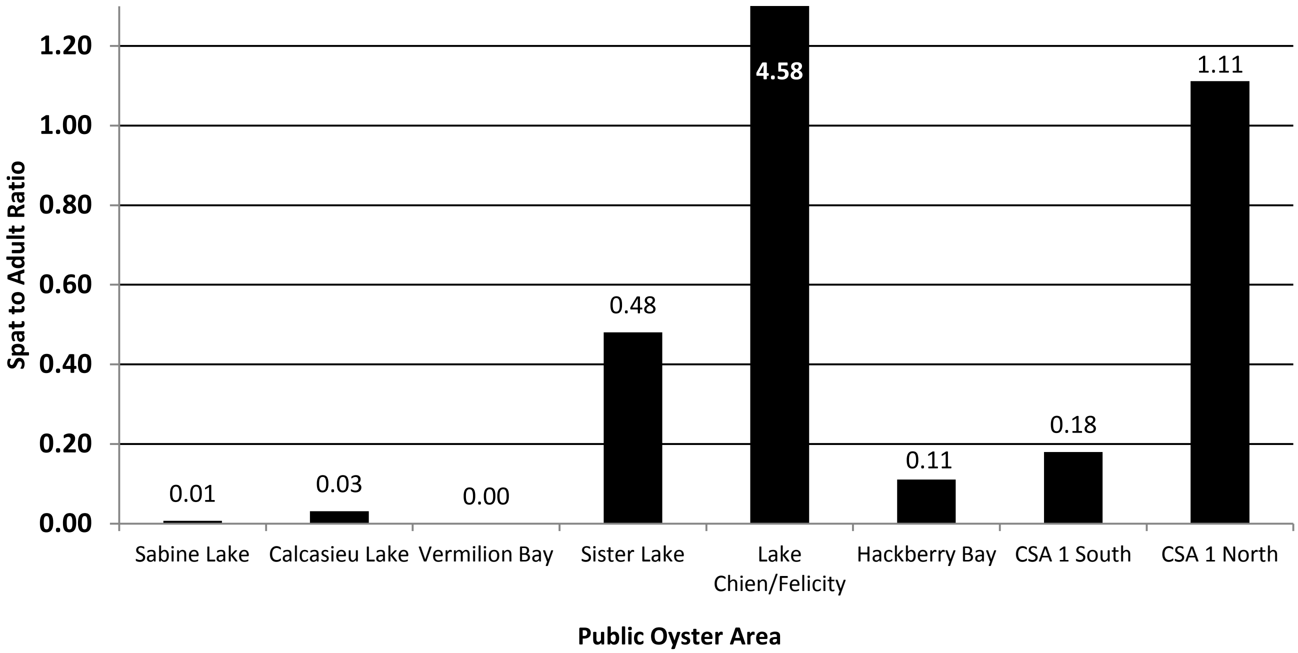
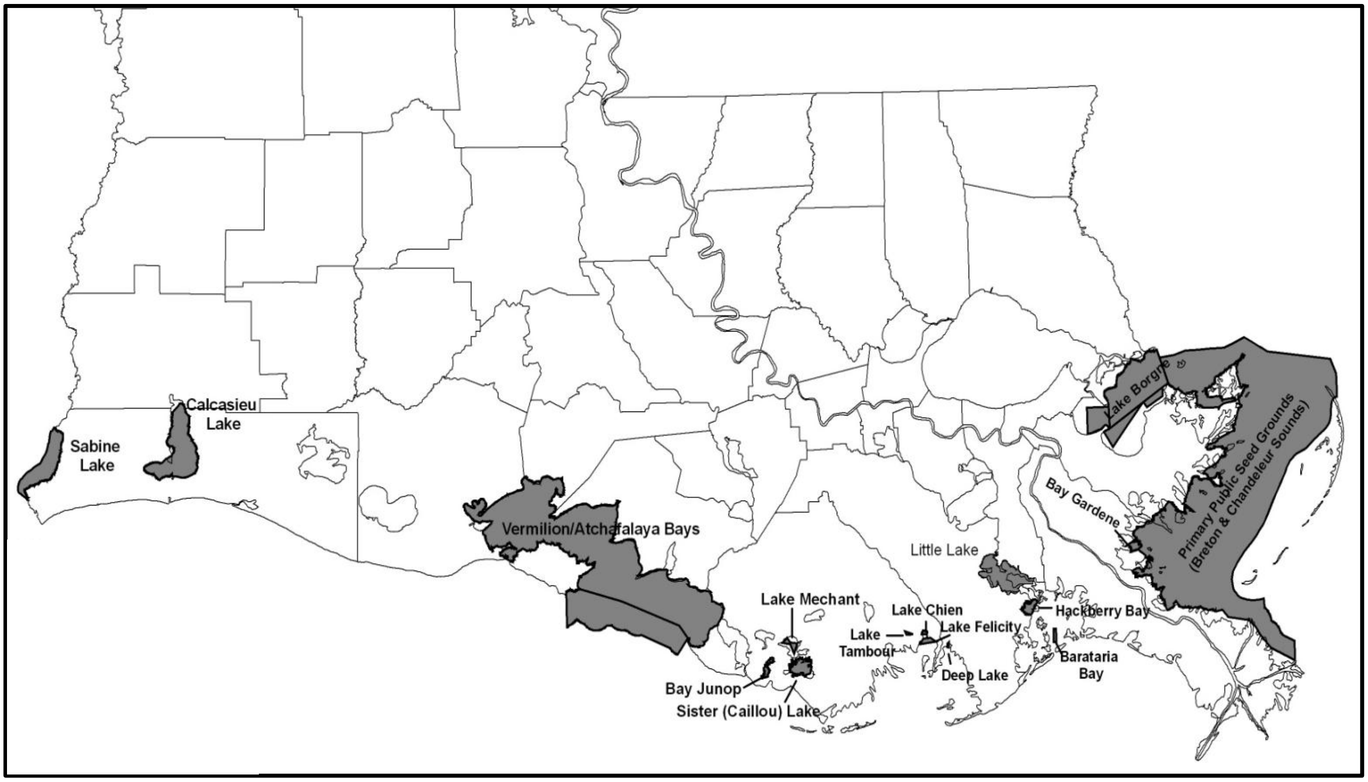


Figure 10. Spat to adult ratios for public oyster areas in Louisiana. "Adult" refers to live oysters 25mm and greater (≥ 1 inch) and "spat" refers to live oysters < 25mm (< 1 inch).

Table 4. Recent cultch planting projects performed in public oyster areas

Year	Location	Cultch Type	Volume (yd^3)	Acreage	Yards Per Acre	Total Cost	Cost/yd^3	Cost/Acre
Fall 2012	Bay Crabe (South Black Bay)	limestone	20,172.00	200	100.9	$1,068,107.00	$52.95	$5,340.54
Fall 2012	Lake Fortuna	crushed concrete	28,629.00	300	95.4	$1,332,657.00	$46.55	$4,442.19
Spring 2013	MS Sound (3-mile Pass)	limestone	40,504.07	158	256.4	$1,526,193.27	$37.68	$9,659.45
Spring 2013	Drum Bay	limestone	18,311.79	200	91.6	$1,019,783.84	$55.69	$5,098.92

Public Oyster Areas



Public Seed Grounds*

- Lake Borgne
- Chandeleur/Breton Sound
  (Primary Public Oyster Seed Grounds)
- Barataria Bay
- Little Lake
- Deep Lake
- Lake Chien
- Lake Felicity
- Lake Tambour
- Lake Mechant
- Vermilion/Cote Blanche/Atchafalaya Bays

Public Seed Reservations**

- Bay Gardene
- Hackberry Bay
- Sister (Caillou) Lake
- Bay Junop

Public Oyster Areas**

- Calcasieu Lake
- Sabine Lake

*Seed grounds are designated by the Louisiana Wildlife and Fisheries Commission
**Seed reservations, Calcasieu Lake, and Sabine Lake are designated by the state legislature

North Pontchartrain Basin (CSA 1N) – 2013 Oyster Stock Assessment

Introduction

The Public Oyster Seed Grounds (POSG) in the North Pontchartrain Basin consist of approximately 690,000 water bottom acres located within Lake Borgne, the Louisiana portion of Mississippi Sound, Chandeleur Sound and adjacent waters. These oyster areas are harvested by Louisiana, Mississippi and Texas fisherman, and have historically been areas of high oyster production within the state of Louisiana. Although managed as public oyster seed grounds by the State for many decades before, the majority of this area was not designated as such by Louisiana Wildlife and Fisheries Commission rule until 1988. Much of Lake Borgne was later added as a public oyster seed ground in 1995 and was expanded in 2004. The Department also continually expands and enhances the public oyster reefs through the placement of cultch material (i.e. shell, limestone, crushed concrete) on suitable water bottoms. Most recently cultch plants were completed in Three-Mile Bay (Shell Point) in 2009, Mississippi Sound (Round Island) in 2011, Three-Mile Pass in 2013, and Drum Bay in 2013.

Currently, these areas are managed to balance the economic opportunity of the fishery with the biological sustainability of the resource. This management is contingent upon obtaining and utilizing the best fishery dependent and independent data available. This includes monitoring the harvest and resource availability throughout the fishing season and performing yearly stock assessments. The information these data provide allow resource managers to implement management changes to both effectively utilize the current resource as well as protect long term viability. This report will fulfill one of those data needs by providing estimates of the current stock size of the oyster resource within this Basin.

Methods

Data for this Oyster Stock Assessment (OSA) was collected between July 01 and July 10, 2013. Divers removed by hand all live and dead oysters, as well as any surficial cultch material from within a one square-meter frame placed directly on the water bottom. Live and dead oysters, spat, fouling organisms, and oyster predators were identified and enumerated. A total of 17 stations were sampled with five square-meter replicates taken at each station. The average of the replicates was then pooled within reef systems. This average density per reef system was multiplied by the total area of the reef systems. Likewise, data was collected at 3 recent cultch plant sites, with the only difference in methodology being that divers used a frame measuring ¼ meter square. The resulting numbers were adjusted into a barrel unit of measure where one barrel equals 720 seed-sized oysters or 360 market-sized (sack) oysters. Seed oysters are those measuring between 25 and 74 mm with market oysters being greater than 74 mm. Spat oysters are those 24mm and less.

As stated in the previous paragraph, the average density of oyster resource per reef system was multiplied by the total area of the reef system to find the total estimated oyster resource. The amount of assessed reef acreage in previous years' Oyster Stock Assessments was estimated at 20,442.48 water bottom acres, based upon water bottom surveys completed in the mid-1970's. In an effort to better locate and assess the oyster resource in the Public Oyster Seed Grounds, a number of side-scan sonar studies of water bottoms in these areas have been conducted in recent years. These side-scan studies coupled with historic reef and cultch plant information have resulted in a more up-to-date and realistic designation of productive water bottoms for use in this annual Oyster Stock Assessment

(Table 1.1). This 2013 Oyster Stock Assessment is based on the updated reef assessment of 22,427.06 water bottom acres, which includes 649 acres of recent cultch plants. As those cultch plants are sampled by a slightly different method and are likely distinctly different from surrounding, existing reef in terms of oyster productivity, the cultch plant acreages are assessed separately and not as part of the surrounding reef complex. It is noted that the reef acreage for Millenium Reef, in western Mississippi Sound, has been added to a reef complex that includes Grassy Island, Halfmoon Island, Petit Island and Grand Banks. Millenium Reef's 70 acres had previously been assessed as a separate reef ever since it was constructed in 2000. Side-scan sonar studies revealed that the majority of this reef fell within the Halfmoon Island reef complex and biological sampling has indicated that it is not distinctively different from surrounding reef acreage. It is also noted that the Public Oyster Seed Grounds located within Lake Borgne were not included is this assessment due to a lack of reef acreage information.

Table 1.1. Comparison of historical and current reef complex acreages

Change in Reef Acreages			
Station Name	**Station Number**	**Historical Reef Acreage**	**Current Reef Acreage**
Grassy Island	3005	6559.17	5327.98
Halfmoon Island	3010		
Petit Island	3009		
Grand Banks	3044		
Millenium	3011	70	
Three Mile Bay	3008	3058.65	3058.65
East Karako Bay	3040		
West Karako Bay	3041		
Grand Pass	3007	1801.76	5410.97
Cabbage	3006		
Turkey Bayou	3004		
Martin Island	3046	4155.7	3183.26
Holmes Island	3045		
Johnson Bayou	3051	200	200
Drum Bay	3049	1596	1596
Morgan Harbor	3050	2954	2954
Shell Point	3052	47.2	47.2
Round Island	3056	Not Assessed	291
Drum Bay Cultch (2013)		Not Assessed	200
Three Mile Pass Cultch (2013)		Not Assessed	158
	Total	**20,442.48**	**22,427.06**

Results and Discussion

Seed and Sack Stock

The current stock size is estimated at 425,896 barrels (bbls) of seed-size oysters and 24,753 bbls of market-size (sack) oysters, for a total of 450,648 bbls of overall stock (Figure 1.1). These numbers are based on the updated reef acreage of 22,427.06 reef acres. By comparison, the estimated oyster stock would have been 419,503 bbls of seed-size oysters and 25,338 bbls of market-size (sack) oysters, for a total of 444,841 barrels of overall stock had the historical figure of 20,442.5 water bottom acres been used for this assessment. Compared to 2012, there was a 258.6% increase in the seed-size estimate and a 69.9% decrease in the sack-size estimate. This year's assessed seed stock is up 42.2% over the previous ten years' average. Conversely, 2013 assessed sack stock is down 90.0% from the previous ten years' average. This year's sack stock estimate is the lowest recorded since 1996. Total assessed oyster stock for 2013 shows a 124.1% increase from 2012, but down 17.7% from the previous ten years' average. It is important to note that this year's seed stock estimate is largely driven by the seed oyster densities observed on the recent Round Island cultch plant in Mississippi Sound, which accounted for an estimated 338,899 bbls (80%) of seed oysters, as well as 2,617 bbls of sack oysters. Stock size estimated for the 2013 3-Mile Pass cultch plant in Mississippi Sound is 1,421 bbls of seed oysters. Stock size estimated for the 2013 cultch plant in Drum Bay is 899 bbls of seed oysters. No sack oysters were observed at either of these two sites.

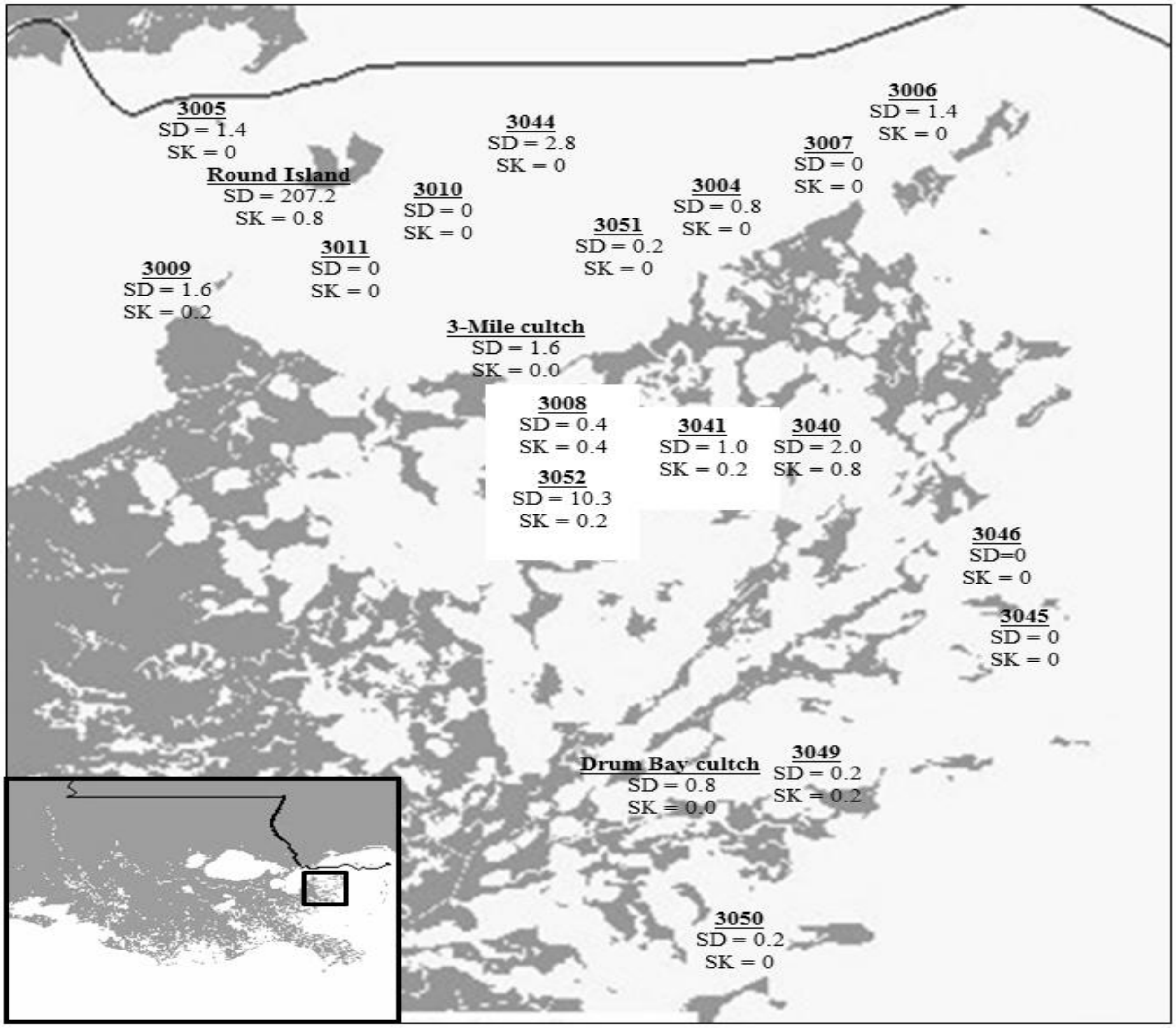


Figure 1.1. Map showing North Pontchartrain Basin oyster stock assessment stations. Numbers below stations are average numbers of seed (SD) and sack (SK) oysters per m^2.

Oyster density and abundance were not evenly distributed among areas (Table 1.2) with the highest density estimates of seed stock found at the Round Island and Shell Point sites and highest density estimates of sack oysters at the Round Island and East Karako sites. Highest overall abundances of seed and sack oysters were at Round Island and the Halfmoon Island reef complex including Grassy Is., Halfmoon Is., Petit Is., Grand Banks and Millenium Reef. It is important to note variability both within and among stations when comparing estimates. This variability is magnified when extrapolating small sample sizes to large areas. In short, changes between annual assessments can be dramatic on an individual reef basis and often only limited areas of large resource availability are identified.

Table 1.2. Mean densities of oysters collected at each station.

Station	Station Number	Reef Group Acreage	Seed Oysters per m2	Sack Oysters per m2	Number of seed oysters (bbls)	Number of sack oysters (bbls)
Grassy Island	3005	5328.0	1.4	0	34738	2,396
Halfmoon Island	3010		0	0		
Petit Island	3009		1.6	0.2		
Grand Banks	3044		2.8	0		
Millennium Reef	3011		0	0		
Three-Mile Bay	3008	3058.7	0.4	0.4	19484	16,046
West Karako Bay	3041		1	0.2		
East Karako Bay	3040		2	0.8		
Grand Pass	3007	5411.0	0	0	22303	0
Cabbage Reef	3006		1.4	0		
Turkey Bayou	3004		0.8	0		
Martin Island	3046	3183.3	0	0	0	0
Holmes Island	3045		0	0		
Shell Point	3052	47.2	10.6	0.2	2812	106
Johnson Bayou	3051	200.0	0.2	0	225	0
Drum Bay	3049	1596.0	0.2	0.2	1794	3,588
Morgan Harbor	3050	2954.0	0.2	0	3321	0
Round Island	3056	291.0	207.2	0.8	338899	2,617
Drum Bay Cultch		200.0	0.8	0	899	0
Three-Mile Pass Cultch		158.0	1.6	0	1421	0
2013 Total					**425,896**	**24,753**

The estimated sack oyster stock continues to fall well below the previous ten years' average, although increases in seed stock were noted during the 2013 stock assessment sampling, primarily due to the abundance of seed on the 2011 Round Island cultch plant location (Figure 1.2). Over the course of the past ten years, there have been several years of heavy localized harvest, high mortality events, strong tropical events such as Hurricanes Katrina in 2005 and Isaac in 2012, the Deepwater Horizon oil spill and related spill response activities and continual limits to recruitment that appear to have severely limited market-size abundances.

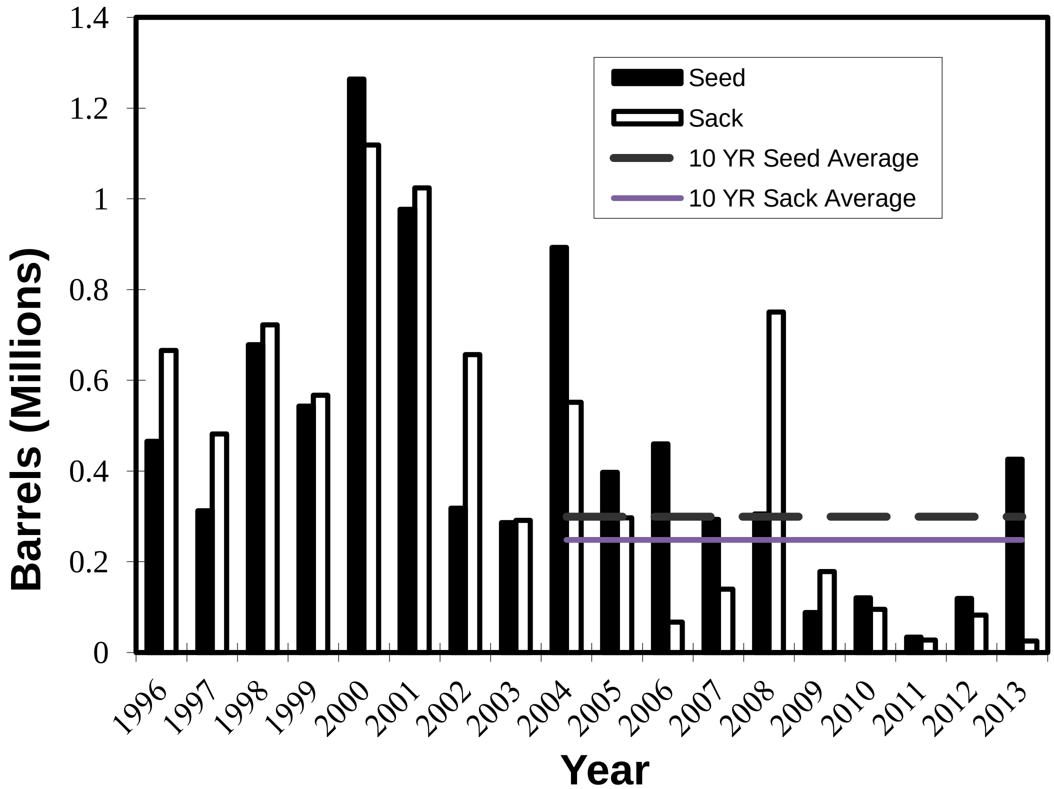


Figure 1.2. Current and historical Stock Assessment (seed and sack oysters) values. Horizontal lines represent the previous ten-years' seed and sack average.

Spat Production

Live spat were observed at 11 of the 20 sites sampled during this assessment. At these sites, mean densities ranged from 0.2 to 204.0 individuals per m^2 with the maximum value occurring at the 2013 Three-Mile Pass cultch plant. Occurrence of spat oysters was once again down substantially from the previous year's assessment. Overall, spat densities were low with the exception of Round Island, Cabbage Reef and the Three-Mile Pass cultch plant. Based on previous years' data, the square meter samples may have occurred between seasonal spawning events in some areas. It is important to note that spat numbers are biased by the amount of substrate collected in a given sample. However, this continues an observed lack of spat set over several of the reef areas during the spring spawning events. This could be attributed to several different things or a combination of stressors discussed below.

Fouling Organisms

The hooked mussel, *Ischadium recurvum*, a sessile bivalve that is often times associated with oyster reefs and likely competes with oysters for food and settlement surfaces were observed at 9 of the 20 sample stations. The highest densities of mussels were 187.8/m^2 at Grassy Island and 123.0/m^2 at Petit Island. (Table 1.3) Higher mussel densities were generally restricted to the lower salinity areas in southern and western Mississippi Sound. Additionally, Spionid polychaetes' mud tubes, ctenostome and fairy lace bryozoans, the tube dwelling amphipod, *Apocorophium*, and other small hydroids continue to be found on live oysters and the exposed shell in the assessment area, as was noted also during 2012 sampling. Such fouling appears to be a limiting factor on the attachment of oyster larvae to the substrate.

Table 1.3. Mean density of the hooked mussel, *Ischadium recurvum*, and the southern oyster drill, *Stramonita haemastoma*, at each station.

Station	*I. recurvum* density/(m^2)	*S. haemastoma* density/(m^2)
Grassy Island	187.8	0
Petit Island	123	0
Halfmoon Island	0	0
Grand Banks	14.0	0
Millennium Reef	0	0
Three-Mile Bay	65.6	0
East Karako Bay	0	0
West Karako Bay	0	0
Grand Pass	0	0
Turkey Bayou	63.8	0.2
Cabbage Reef	0	0
Johnson Bayou	0.8	0
Shell Point	14.2	0.2
Drum Bay	0	0.2
Morgan Harbor	0	0
Martin Island	0	0
Holmes Island	0	0
Round Island	106	0
Drum Bay Cultch	0	0
3-Mile Pass Cultch	0.8	0

Oyster Predators and Disease

The southern oyster drill (*Stramonita haemastoma*) is a predatory marine gastropod known to prey on oysters and other sessile animals using a small tooth-like scraping organ called a radula to bore a hole through the oyster shell. Oyster drills were collected at only three of the sample stations. No oyster drill egg casings were observed. Additionally, another predatory snail, the shark-eye or Atlantic moon snail (*Neverita duplicata*) was observed at the Grand Pass site. No stone crabs, *Menippe adinia*, or blue crabs, *Callinectes* spp., were collected in the square meter samples. Other Xanthid crabs were noted in the samples that contained shell for substrate.

Dermo, *Perkinsus marinus*, a protozoan parasite that infects live oyster tissue, is known to cause extensive oyster mortalities especially under high salinity and water temperature conditions. Oyster tissue samples to be tested for presence of this parasite were collected at two sites in North Pontchartrain Basin, Cabbage Reef and Three-Mile Bay. Results of the Dermo tests are presented in another section of this report.

Mortality

Mortality estimates show a decrease compared to last year, but are still highly variable between size classes and stations (Table 1.4) during this sampling event. Spat mortalities ranged from 0% to 100%. The highest spat mortalities were located at the Johnson Bayou and Shell Point sites. Seed mortalities were observed at two of the sample sites. Shell Point had a seed mortality of 10.2% and Round Island had a seed mortality of 1.89%. There was no sack mortality observed in the assessment sampling. It is important to take into consideration that these mortality estimates are often based on an extremely small number of animals. For many of these areas, assessment samples were taken after apparently large mortality events that have either subsided or have severely depleted abundances (see Cumulative Impacts and Mortalities section below).

Table 1.4. Mean oyster mortality (recent) estimates from North Pontchartrain Basin m^2 sample stations; N/A = no live or dead oysters were collected for mortality estimates

Station	Spat Mortality (%)	Seed Mortality (%)	Sack Mortality (%)
Grassy Island	0	0	N/A
Petit Island	0	0	0
Halfmoon Island	N/A	N/A	N/A
Grand Banks	N/A	0	N/A
Millennium Reef	N/A	N/A	N/A
Three-Mile Bay	N/A	0	0
West Karako Bay	0	0	0
East Karako Bay	0	0	0
Shell Point	81.25	10.2	0
Johnson Bayou	100	0	N/A
Turkey Bayou	0	0	N/A
Cabbage Reef	2.6	0	N/A
Grand Pass	0	N/A	N/A
Drum Bay	N/A	0	0
Morgan Harbor	N/A	0	N/A
Martin Island	N/A	N/A	N/A
Holmes Island	N/A	N/A	N/A
Round Island	18.75	1.89	0
Drum Bay Cultch	0	0	N/A
3-Mile Pass Cultch	0.77	0	N/A

Tropical and Climatic Events

Hurricane Isaac (August 28, 2012) was a significant tropical system impacting the public oyster seed grounds in the Pontchartrain Basin during this assessment period. Immediately following the storm's passage, biologists observed increased sedimentation across the assessment area. Further, large amounts of marsh vegetation were observed in post-storm monitoring of oyster reefs. There seemed to be only minimal residual impact to the area's oyster seed grounds, as less and less incidences of overburden were observed during subsequent sampling events.

The Pearl River system provided a relatively large volume of fresh water into the western Mississippi Sound in March 2013. This event depressed the salinities on the reef systems in the Mississippi Sound. The salinities at Grassy Island and Petit Island were consistently less than 5 parts per thousand (ppt) for the months of February through May 2013 (Figure 1.3).

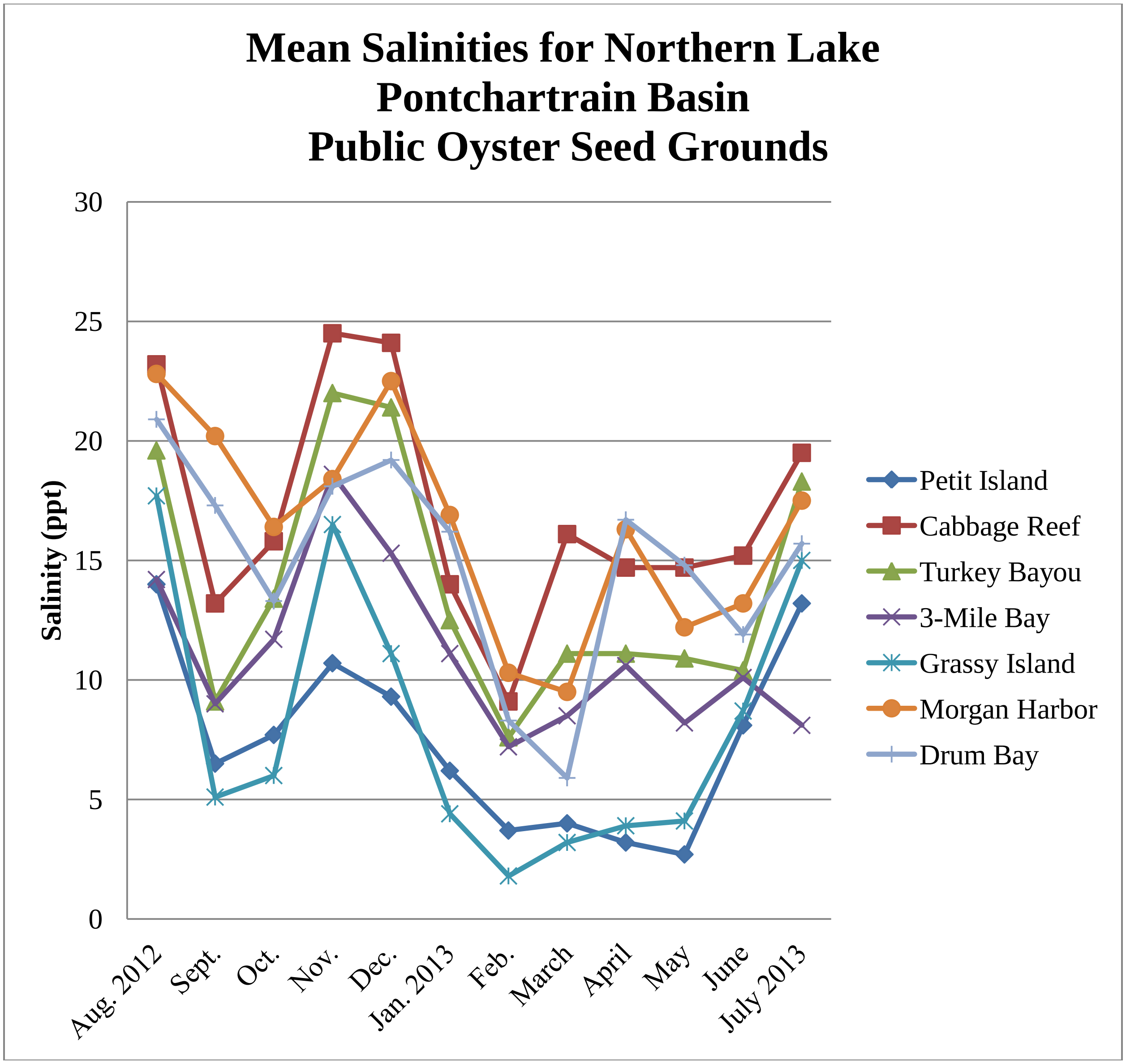


Figure 1.3. Salinities for the Northern Lake Pontchartrain Basin Public Oyster Seed Grounds since 2012 Assessment. Data presented are from discrete measurements on each reef.

<u>Cumulative Impacts and Mortalities</u>

This section will focus on greater detail concerning environmental conditions observed, as well as direct impacts that have occurred since the previous stock assessment in 2012. It is important to note that many of the topics listed below are correlated with one another, i.e. freshwater inputs-salinity stratification-hypoxia.

Deepwater Horizon Oil Spill and Related Response Actions

The Deepwater Horizon oil spill released millions of barrels of oil into the Gulf of Mexico affecting the Louisiana coastline. In direct response to the oil spill, in an effort to keep incoming oil from the Gulf out of Louisiana's sensitive marshes and estuaries, freshwater was released from diversions and siphons along the Mississippi River. The impacts of oil and freshwater diversions on oyster health and habitat continue to be of concern. Assessments on the direct and indirect impacts of oil and response actions on Louisiana's near shore environment, including oysters and oyster habitat is ongoing.

Hypoxia

The definition of hypoxia varies as it is based on the percent saturation of water by oxygen. This varies with temperature and amount of other solutes. For most environmental assessments in this area, hypoxia can be viewed as concentrations of dissolved oxygen below 3 milligrams per liter (mg/L). As oysters are a sessile species, reef systems can often be impacted by hypoxia in an estuarine setting. Within the Pontchartrain Basin estuary, the most common driver of hypoxia over reef systems is the stratification of the water column due to density differences in water masses. These density differences are oftentimes driven by salinity and temperature. Basically, warmer, fresher water overrides denser salt water and does not allow the diffusion of oxygen throughout the water column. This is common in areas that have experienced high fresh water inputs, especially after the return of higher salinity waters once fresh water inputs subside. In other cases, in relatively confined areas, increases in biological oxygen demand can also lead to hypoxia, although localized. Some instances of hypoxia are "usual" in most areas, but prolonged exposure can result in reduced growth, decreased disease resistance, or direct mortality. At the time of the 2013 assessment, there was no hypoxia detected on North Pontchartrain Basin reef systems.

Freshets

The Pearl River system had a higher than normal discharge rate in the winter and spring months of 2013. The POSG in western Mississippi Sound are impacted by this higher discharge rate. This is evidenced by salinities being recorded as low as 1.8ppt at Grassy Island and 2.7ppt at Petit Island. Although these values are discreet measurements, similar low salinity values were also collected by non-related observations, as well as data derived from continuous salinity recorders within the area.

While freshets often provide benefits to the reef system, either by reducing disease or predation, or by enhancing cultch opportunities, there are often other cumulative impacts that may affect recovery from any one event. The impact/recovery are also modified by not only the magnitude of a freshet, but perhaps also by the duration and timing.

Sedimentation/Subsidence

During periods of high freshwater input, sedimentation over reefs can be a problem. This sedimentation can affect the reef either through direct mortality (burial) or through reduced growth and reproduction (both production and clean places for larval attachment). During the 2013 assessment, divers noted on many reefs, especially in the Mississippi Sound area, that some of the cultch had a covering of silt and still other areas were buried. Both of these conditions limit the amount of suitable substrate available for larval settlement.

Subsidence of the reefs is usually balanced by reef accretion or growth. If no appreciable shell is added over a period of time, the reefs, especially those in less than optimal environments, will subside to the point of shell burial. The lowering of the reef profile also subjects associated organisms to more frequent hypoxia events as well as changing the local water flow and sedimentation process.

Cultch Condition

Any successful spat set is dependent upon clean, stable cultch for larval attachment. The condition of the cultch and live oyster shell within the North Pontchartrain Basin continually appears to be poor. As noted above, many areas are buried or covered with a thin layer of silt. On some reefs in the Mississippi Sound area, the cultch is covered by Spionid polychaetes mud tubes, ctenostome and fairy lace bryozoans, the tube dwelling amphipod, *Apocorophium*, and other small hydroids. In other areas, the addition of shell to a reef has become so infrequent that the cultch on hand is being transformed into small "hash" particles that may not provide optimal substrate for larval attachment.

<u>2012/2013 Oyster Season Summary</u>

Several tools are used by research personnel to estimate harvest and associated activities by the commercial oyster industry during the harvest season.

Harvest estimates are obtained by monitoring the users and by obtaining fishery dependent data. Fishermen are contacted while fishing and asked to provide estimates of current and past catch and effort as well as an estimate of future effort. This data is obtained weekly during the oyster season and is used to estimate harvest in a particular reef complex. Harvest data is also obtained via the trip ticket system in place for this fishery. However, trip ticket data is consolidated by geographic region and is considered preliminary until well after the season concludes, and provides a limited resolution.

Fishery independent methods are used to obtain the health and condition of the resource both prior to and during the final stages of the fishing season. Techniques used in these assessments are oyster dredging and visual census. It is important to note that both fishery dependent and independent sources are subject to several large biases and should be used in conjunction to provide a better estimate of the available resource.

The season within the North Pontchartrain Basin oyster seed grounds opened on October 29, 2012 and closed on April 30, 2013. During this time period, the total harvest estimates for the grounds, as determined by harvest surveys (boarding reports) were 2,540 barrels of seed-sized oysters and 3,519 sacks of market-sized oysters for a combined total of 4,300 barrels of oysters. When harvest estimates within stock-assessed areas are compared with the 2012 assessments, there was an estimated utilization of 2.1% of the seed resource, 2.1% of the sack resource, and 2.1% utilization overall. In a general spatial context, this harvest was variable throughout the Basin (Table 1.5). The majority of the observed seed harvest was from Shell Point as 87% of the total seed harvest occurred on this reef. The majority of market-sized resource was observed to be harvested from Three-Mile Bay and West Karako reefs at 25% and 56% respectively of the combined harvested market-sized oyster resource.

Harvest amounts as well as observed vessels were not constant over time. Market oyster harvest was most prominent during the first week of the season with an estimated 928 sacks harvested. The only observed seed oyster harvest was during the first week of the season with 2,540 barrels of seed collected within that period.

Table 1.5. Harvest estimates from the 2012/2013 public season within CSA1.

Station	Seed-size (bbls)	Market-size (sacks)
Grassy Island	0	0
Halfmoon Island	0	25
Petit Island	0	98
Lake Borgne	20	35
Millennium Reef	0	0
Grand Banks	0	0
Three-Mile Bay	195	893
Turkey Bayou	10	0
Johnson Bayou	0	25
Grand Pass	20	15
Cabbage Reef	0	0
West Karako	75	1975
Drum Bay	0	0
Morgan Harbor	0	3
Bay Eloi	0	0
Shell Point	2220	450
Total	**2,540**	**3,519**

It is notable that although some harvest was observed within the northeastern part of Lake Borgne, the southern and western areas of the lake continue to show no viable resource. There was no public harvest observed in those areas during the 2012/2013 season.

While obtaining fishery dependent data, LDWF biologists routinely collect random samples of oyster seed loads from vessels working on the public grounds to check the percent of cultch (non-living reef material) being harvested. Two such samples were collected from two of the five vessels observed collecting seed oysters from the Three-Mile Bay and Shell Point stations. The percentage of cultch material in the sample from the Three-Mile Bay site was calculated to be 71%, while the percentage of cultch material in the sample from the Shell Point site was calculated to be 47.5%. Excessive cultch removal from public reef systems by bedding vessels continues to be a major concern within the Pontchartrain Basin.

South Pontchartrain Basin (CSA 1S) – 2013 Oyster Stock Assessment

Introduction

The public oyster seed grounds in the South Pontchartrain Basin (formerly Coastal Study Area 2) consist of approximately 300,000 water bottom acres located from the Mississippi River Gulf Outlet (MRGO) southward to South Pass in the Mississippi River delta, and eastward from the eastern extent of private leases east of the Mississippi River to the Breton National Wildlife Refuge. These seed grounds include Bay Gardene Public Oyster Seed Reservation, as well as areas designated as "sack harvest only" in Lake Fortuna, Lake Machias, and Bay Long. Historically, this area has provided seed- and market-sized oysters for oyster fishermen from Louisiana, Mississippi and Texas. Hydrology in the area is influenced at high Mississippi River stages by discharge through gaps in the Mississippi River levee south of Pointe a la Hache, such as the Bohemia spillway; discharge from the Caernarvon and Bayou Lamoque fresh water diversion structures; the siphon at White's Ditch; and main-stem river distributaries in the southern portion of the Basin.

The Department of Wildlife and Fisheries continually expands and enhances the public oyster reefs through the placement of cultch material (i.e. shell, limestone, crushed concrete) on suitable water bottoms. Numerous cultch plants have been constructed throughout this Basin since 1917, including sites in Bay Gardene and Black Bay. Most recently cultch plants were completed near Stone Island in 2009, in California Bay in 2011 and in Bay Crabe and Lake Fortuna in 2012.

Currently, this area is managed to balance the economic opportunity of the fishery with the biological sustainability of the resource. This management is contingent upon obtaining and utilizing the best fishery dependent and independent data available. This includes monitoring the harvest and resource availability throughout the fishing season and performing yearly stock assessments. The information these data provide allow resource managers to implement management changes to both effectively utilize the current resource as well as protect long term viability. This report will fulfill one of those data needs by providing estimates of the current stock size of the oyster resource within this Basin.

Methods

Data was collected between June 27 and July 16, 2013. Divers removed by hand all live and dead oysters, as well as any surficial cultch material from within a one square-meter frame randomly placed on the water bottom. Live and dead oysters, spat, fouling organisms, and oyster predators were identified and enumerated. A total of 30 stations were sampled with five square-meter replicates taken at each station (Figure 2.1). The average of the replicates was then pooled within reef systems. This average density per reef system was multiplied by the total area of the reef systems. Likewise, data was collected at three recent cultch plant sites, with the only difference in methods being that divers used a frame measuring ¼ meter square. The resulting

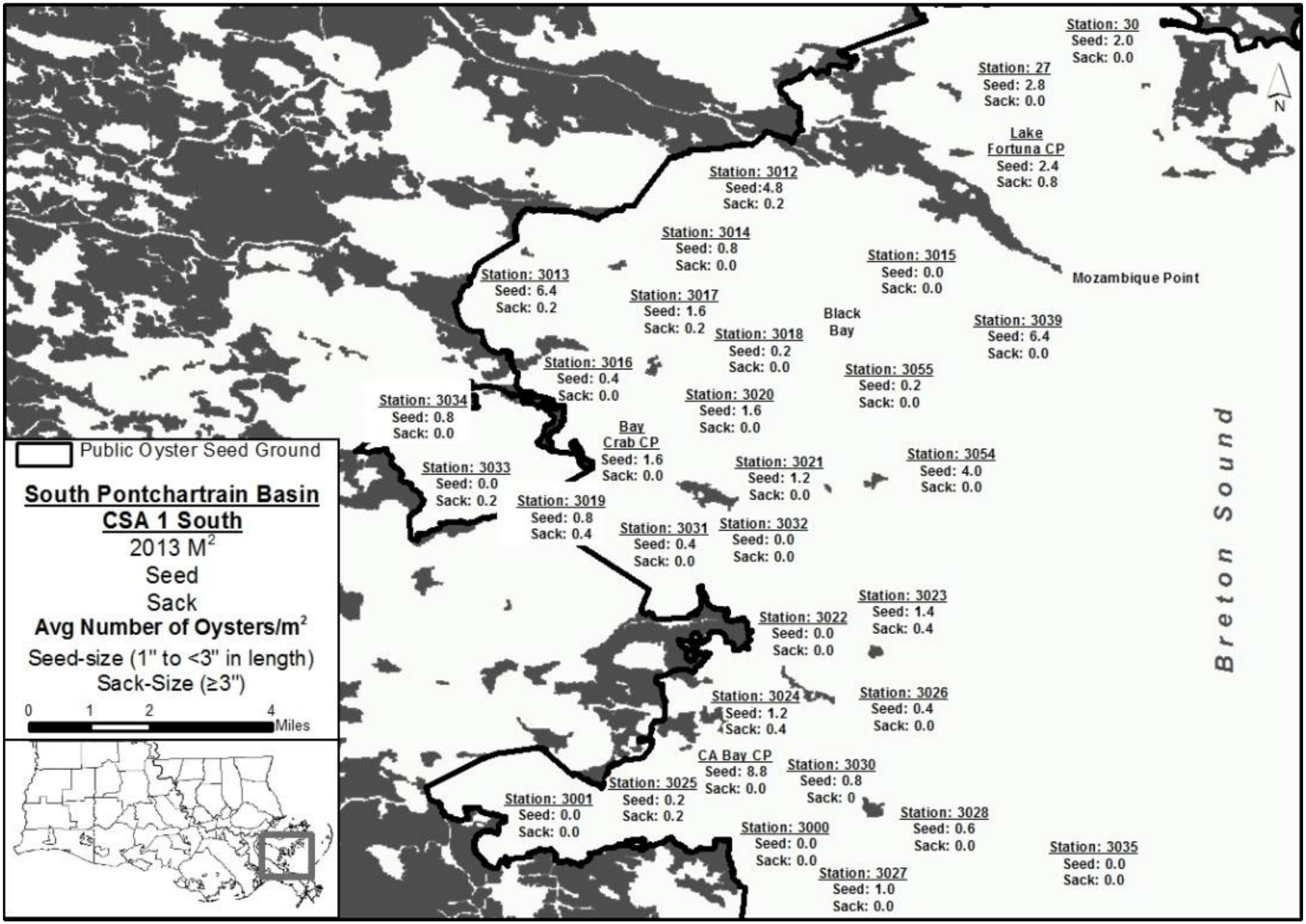


Figure 2.1. Map showing stock assessment sample stations within Coastal Study Area 1-South. Station numbers are in bold and data below indicate the average number of seed (SD) and sack (SK) oysters collected per sample at that station.

numbers were adjusted into a barrel unit of measure where one barrel equals 720 seed-sized oysters or 360 market-sized (sack) oysters. Seed oysters are those measuring between 25 and 74 mm with market oysters being greater than 74 mm. Spat oysters are those 24mm and less. Previous years' stock assessments for the South Pontchartrain Basin have been based upon an acreage value of 16,644 acres, as was determined by water bottom surveys completed in the mid-1970's. In an effort to better locate and assess the oyster resource in the public oyster seed grounds, a number of side-scan sonar studies of water bottoms in the South Pontchartrain Basin have been conducted in recent years. These side-scan studies coupled with historic reef and cultch plant information have resulted in a more up-to-date and realistic designation of productive water bottoms for use in this annual Oyster Stock Assessment (Table 2.1).

Table 2.1. Comparison of historical and current reef complex acreages. CP = cultch plant.

Complex Name	Station Name	Station #	Old #	Historic Acreage	New Acreage
East Black Bay	Jessies Island	3013	2	59.00	
	Bayou Lost	3016	5	118.00	549.89
Bay Gardene	Bay Gardene	3034	24	69.00	
	East Bay Gardene	3033	23	28.00	1,262.64
Bay Crabe	West Bay Crabe	3019	8	501.00	
	Bay Crabe	3031	21	659.00	
	East Bay Crabe	3032	22	122.00	1,531.96
Elephant Pass	Elephant Pass	3022	11	339.00	202.21
California Bay	Sunrise Point	3027	16	174.00	
	California Bay	3025	14	7.00	
	West Pelican Island	3030	20	293.00	
	Bay Long	3001	17	572.00	3,392.78
Mangrove	Mangrove	3000	19	937.00	
	East Pelican	3028	18	782.00	2,889.11
South Black Bay	Stone Island	3020	9	461.00	
	South Black Bay	3021	10	145.00	
	Curfew Island	3023	12	425.00	
	North California Bay	3024	13	109.00	
	Telegraph Island	3026	15	127.00	3,575.74
Lonesome Island	Snake Island	3012	1	506.00	
	North Lonesome Island	3014	3	896.00	
	Lonesome Island	3017	6	716.00	
	Black Bay	3018	7	301.00	2,861.94
Lake Fortuna	Lake Fortuna South	3036	27	2,144.00	
	Lake Fortuna North	3003	30	2,144.00	3,453.85
Horseshoe Reef	North Black Bay	3015	4	157.50	
	Horseshoe Reef	3039	26	157.50	
	East Stone Island	3055	29	1,138.00	2,485.81
Wreck	Wreck	3054	28	1,138.00	4,485.79
Battledore Reef	Battledore Reef	3035	25	1,419.00	270.57
	California Bay CP (2011)				300.00
	Bay Crabe CP (2012)				200.00
	Lake Fortuna CP (2012)				300.00
			Total	16,644.00	***27,762.29***

This 2013 Oyster Stock Assessment is based on the updated reef acreage of 26,962.29 water bottom acres. This stock assessment further includes 800 acres of recent cultch plants. As those cultch plants are sampled by a slightly different method and are likely distinctly different from surrounding, existing reef in terms of oyster productivity, the cultch plant acreages are assessed separately and not as part of the surrounding reef system. Additionally, oyster reefs within the South Pontchartrain Basin, each of which was previously represented by one of thirty square-meter sample stations, were grouped into reef complexes for the 2013 stock assessment. The reefs placed within a reef complex were those closely related in regards to location, hydrology, oyster productivity, and response to environmental stresses. A total of twelve reef complexes were designated, each with 1 to 5 representative square-meter sample stations. An additional 1,524 acres of oyster habitat (reef and scattered shell) was identified by the recent water bottom assessments, but was not included in the 2013 stock assessment acreage as it was felt that no current oyster sampling station adequately described this acreage (Figure 2.2).

Figure 2.2. Reef complex designations in Coastal Study Area 1-South based on recent water bottom assessments (side-scan sonar).

Results and Discussion

Seed and Sack Stock

The current stock size for the South Pontchartrain Basin is estimated at 282,331.90 barrels (bbls) of seed oysters and 18,586.55 bbls of market sized oysters for a total of 300,918.45 bbls of overall stock. These numbers include assessed reef acreage of 27,762.29 water bottom acres, including 800 acres of cultch plants. By comparison, the estimated oyster stock would have been 146,918 bbls of seed-size oysters and 9,411 bbls of market-size (sack) oysters, for a total of 156,329 barrels of overall stock had the historical figure of 16,644 water bottom acres and the individual reef method been used for this assessment. Compared to 2012, there was a 5335.73% increase in the seed-size estimate and a 31.42% decrease in the sack-size estimate. Overall abundance increased 831.75% from last year's Oyster Stock Assessment. Overall oyster stock for the South Pontchartrain Basin is down 49.97% from the previous 10 years' average (2003 - 2012), and down 79.31% from the long term average (1982 – 2012). Although, the seed oyster stock estimate for 2013 shows a tremendous increase from the 2012 Oyster Stock Assessment, it is still down 28.98% from the previous 10 years' average, and down 67.89% from the long term average. It is important to note that the 2012 seed stock estimate was the lowest observed since 1982. The 2013 sack stock estimate is 90.89% below the previous ten years' average, and 96.77% less than the long-term average (Figure 2.3). The 2013 sack oyster stock is the lowest estimated sack abundance since 1991.

Oyster density and abundance was not evenly distributed among areas (Table 2.2). The highest average density of seed oysters was found at Jessie's Island, Horseshoe Reef, and Snake Island. Highest abundance of seed stock was observed within the Wreck reef complex, where assessed acreage was increased over three-fold. The highest average density of sack-sized oysters was located at the Lake Fortuna cultch plant, Curfew Island, West Bay Crabe, and North California Bay. The highest total abundance of sack oysters was found at the South Black Bay Reef complex, which includes Curfew Island and North California Bay. The assessed acreage within this reef complex increased nearly three-fold over previous years' assessments.

As earlier stated, seed-sized oyster stock increased dramatically from 2012 levels and seed oysters were found at 26 of the 33 stations sampled for this assessment. Approximately 16.5% of seed oysters are located in the Lake Fortuna reef complex, which has been historically designated as sacking only (not available for bedding). An additional 7.3% of estimated seed oyster stock is located on recent cultch plants, also not currently available for harvest. Sack-sized oyster stock decreased significantly from 2012 levels and sack oysters were observed at only 9 sample sites. Approximately 14.5% of estimated sack oyster stock was located within the recent Lake Fortuna cultch plant.

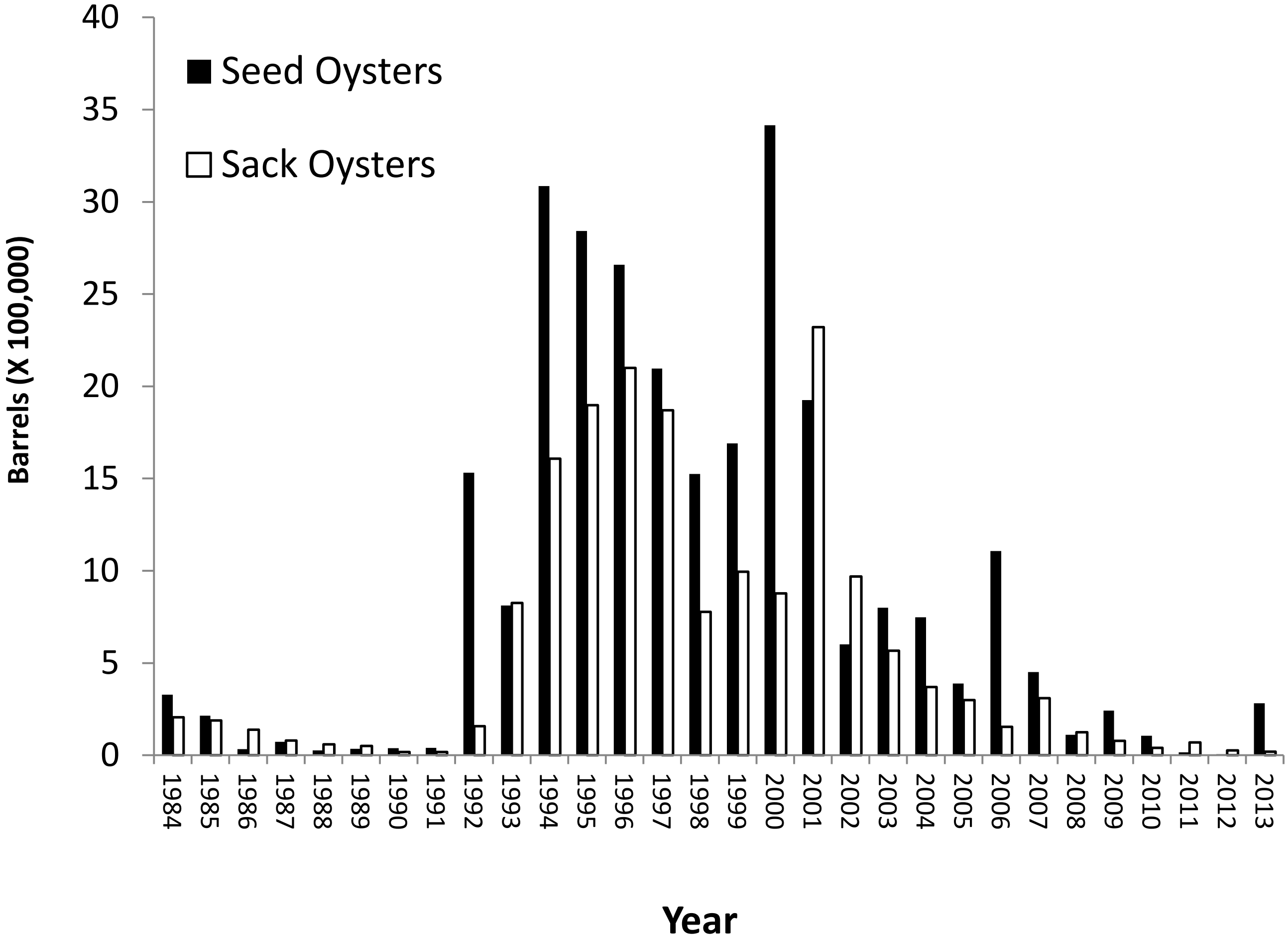


Figure 2.3. Current and historical stock assessment (seed and sack oysters) values.

Spat Production

Live spat were observed at 10 of the 33 stations sampled during this assessment. Spat densities observed during this Oyster Stock Assessment ranged from 0 to 3.8/m2. Although these assessment events may occur outside of the peak spawning period, it is evident that there has been only minimal spat catch on these reefs. This marks a continuation of poor spat catches within this Basin. This may be attributed to several causes discussed below.

Mortality

Spat mortalities ranged from 0.0 to 100% at the 10 stations where spat oysters were observed. There was seed mortality ranging from 0.0 to 50% at 7 of the 26 sites where seed stock was observed. There was sack-sized mortality of 50% at 1 of the 9 stations where sack-sized oysters were observed.

Table 2.2. Mean densities of oysters collected at each station.

Station Name	Station Number	Mean densities spat	Mean densities seed	Mean densities sack	Barrels of seed oysters	Barrels of sack oysters
Jessies Island	3013	0.00	6.40	0.20	10,508.53	618.15
Bayou Lost	3016	0.00	0.40	0.00		
Bay Gardene	3034	0.00	0.80	0.00	2,838.75	1,419.37
East Bay Gardene	3033	0.00	0.00	0.20		
West Bay Crabe	3019	0.00	0.80	0.40	3,444.25	2,295.59
Bay Crabe	3031	0.00	0.40	0.00		
East Bay Crabe	3032	0.00	0.00	0.00		
Elephant Pass	3022	0.00	0.00	0.00	0.00	0.00
Sunrise Point	3027	0.00	1.00	0.00	9,534.83	1,906.97
California Bay	3025	0.00	0.20	0.20		
West Pelican Island	3030	0.00	0.80	0.00		
Bay Long	3001	0.00	0.00	0.00		
Mangrove	3000	0.00	0.00	0.00	4,871.61	0.00
East Pelican	3028	0.20	0.60	0.00		
Stone Island	3020	0.00	1.60	0.00	23,313.69	6,431.36
South Black Bay	3021	0.40	1.20	0.00		
Curfew Island	3023	0.00	1.40	0.40		
North California Bay	3024	0.00	1.20	0.40		
Telegraph Island	3026	0.00	0.40	0.00		
Snake Island	3012	0.40	4.60	0.20	28,954.77	3,217.20
North Lonesome Island	3014	0.20	0.80	0.00		
Lonesome Island	3017	0.20	1.60	0.20		
Black Bay	3018	0.00	0.20	0.00		
Lake Fortuna South	3036	0.00	2.80	0.00	46,590.97	0.00
Lake Fortuna North	3003	0.20	2.00	0.00		
North Black Bay	3015	0.00	0.00	0.00	30,738.15	0.00
Horseshoe Reef	3039	3.80	6.40	0.00		
East Stone Island	3055	0.00	0.20	0.00		
Wreck	3054	1.80	4.00	0.00	100,852.35	0.00
Battledore Reef	3035	0.00	0.00	0.00	0.00	0.00
California Bay CP (2011)		2.40	8.80	0.00	14,838.53	0.00
Bay Crabe CP (2012)		0.00	1.60	0.00	1,798.61	0.00
Lake Fortuna CP (2012)		1.60	2.40	0.80	4,046.87	2,697.92
2013 Total					**282,331.90**	**18,586.55**

Fouling Organisms

Hooked mussels (*Ischadium recurvum*) are a sessile bivalve that is oftentimes associated with oyster reefs and compete with oysters for food and settlement surfaces. During this assessment hooked mussels were present at 30 of the 33 stations sampled and ranged in density from 0.2 to 2,561.2 individuals / m^2 (Table 2.3).

Overall hooked mussel density has decreased over the previous assessment with the largest decrease in density coming from reefs in California Bay at Sunrise Point, which was the site of largest increase during last year's assessment. Increases in hooked mussel density were observed at 8 of our 33 stations. Notably, large increases were found at Bay Gardene and Bay Long. Additionally, Spionid polychaete mud tubes, ctenostome and fairy lace bryozoans, the tube dwelling amphipod, *Apocorophium,* and other small hydroids continue to be found on live oysters and the exposed shell in the assessment area, as was noted in the 2012 Oyster Stock Assessment. Such fouling appears to be a limiting factor on the attachment of oyster larvae to the substrate.

Oyster Predators/Disease

The southern oyster drill (*Stramonita haemastoma*) is a predatory marine gastropod known to prey on oysters and other sessile animals using a small tooth-like scraping organ called a radula to bore a hole through the oyster shell. Snails were found at just one station (Lake Fortuna North) with no egg cases found in any of the samples. The recent extended periods of low salinity may have limited snail abundance in the area. Three stone crabs (*Mennipe adinia*), and no blue crabs (*Callinectes sapidus*) were observed in the samples.

Perkinsus marinus (= Dermo), a protozoan parasite that infects oyster tissue, is known to cause extensive oyster mortalities especially under high salinity and high water temperature conditions. Dermo samples were attempted at 7 stations throughout the area. Results of the Dermo tests are presented in another section of this report.

Tropical and Climatic Events

Hurricane Isaac (August 28, 2012) was a significant tropical system impacting the public oyster seed grounds in the Pontchartrain Basin during this assessment period. Immediately following the storm's passage, biologists observed increased sedimentation across the assessment area. Further, large amounts of marsh vegetation were observed in post-storm monitoring of oyster reefs. Initial oyster resource impacts were noted, as well. Oyster spat mortalities were measured at 70% at Lake Machias and 77.8% at Lake Fortuna North. Seed- and Sack-sized oyster mortalities were found to be 57.1% at Lake Machias and 28.6% at both the North Fortuna and Lake Fortuna sites. There seemed to be only minimal residual impact to the area's oyster seed grounds, as less and less incidences of oyster mortality or overburden were observed during subsequent sampling events.

Table 2.3. Mean density of the hooked mussel, *Ischadium recurvum*, and the southern oyster drill, *Stramonita haemastoma*, at each m^2 station.

Complex Name	Station Name	Station Number	*I. recurvum* density/(m^2)	*S. haemastoma* density/(m^2)
East Black Bay	Jessies Island	3013	42.2	0
	Bayou Lost	3016	425.2	0
Bay Gardene	Bay Gardene	3034	2561.2	0
	East Bay Gardene	3033	91.4	0
Bay Crabe	West Bay Crabe	3019	215.6	0
	Bay Crabe	3031	758.2	0
	East Bay Crabe	3032	212.6	0
Elephant Pass	Elephant Pass	3022	526.4	0
California Bay	Sunrise Point	3027	15.0	0
	California Bay	3025	328.8	0
	West Pelican Island	3030	157.6	0
	Bay Long	3001	1622.8	0
Mangrove	Mangrove	3000	717.2	0
	East Pelican	3028	140.0	0
South Black Bay	Stone Island	3020	169.2	0
	South Black Bay	3021	228.8	0
	Curfew Island	3023	3.6	0
	North California Bay	3024	231.8	0
	Telegraph Island	3026	141.2	0
Lonesome Island	Snake Island	3012	116.2	0
	North Lonesome Island	3014	31.8	0
	Lonesome Island	3017	48.0	0
	Black Bay	3018	33.0	0
Lake Fortuna	Lake Fortuna South	3036	0	0
	Lake Fortuna North	3003	0	0.4
Horseshoe Reef	North Black Bay	3015	0	0
	Horseshoe Reef	3039	1.4	0
	East Stone Island	3055	36.2	0
Wreck	Wreck	3054	17.4	0
Battledore Reef	Battledore Reef	3035	0.2	0
	California Bay CP (2011)		14.4	0
	Bay Crabe CP (2012)		6.4	0
	Lake Fortuna CP (2012)		11.2	0

The main input of freshwater to the Basin was from discharge through fresh water diversion structures and through gaps in the levee south of Pointe a la Hache, as well as main-stem distributaries during high Mississippi River stages. Salinities across the entire Basin were consistently at or above the 7 parts per thousand (ppt) mark throughout most of the assessment year. (Figure 2.4) There was a notable decrease in salinity across a majority of the Basin during the month of May 2013. During this period salinities at E. Bay Gardene, E. Bay Crabe, and

Stone Island fell to 3.7, 5.4 and 6.4ppt respectively. Conversely, the salinity at Mangrove Pt. climbed to near 10ppt during the same period.

Cumulative Impacts and Mortalities

This section will focus on greater detail concerning environmental conditions observed, as well as direct impacts that have occurred since the previous stock assessment in 2012. It is also important to note that many of the topics listed below are correlated with one another, i.e. freshwater inputs-salinity stratification-hypoxia.

Deepwater Horizon Oil Spill and Related Response Actions

The Deepwater Horizon oil spill released millions of barrels of oil into the Gulf of Mexico affecting the Louisiana coastline. In direct response to the oil spill, in an effort to keep incoming oil from the Gulf out of Louisiana's sensitive marshes and estuaries, freshwater was released from diversions and siphons along the Mississippi River. The impacts of oil and freshwater diversions on oyster health and habitat continue to be of concern. Assessments on the direct and indirect impacts of oil and response actions on Louisiana's near shore environment, including oysters and oyster habitat is ongoing.

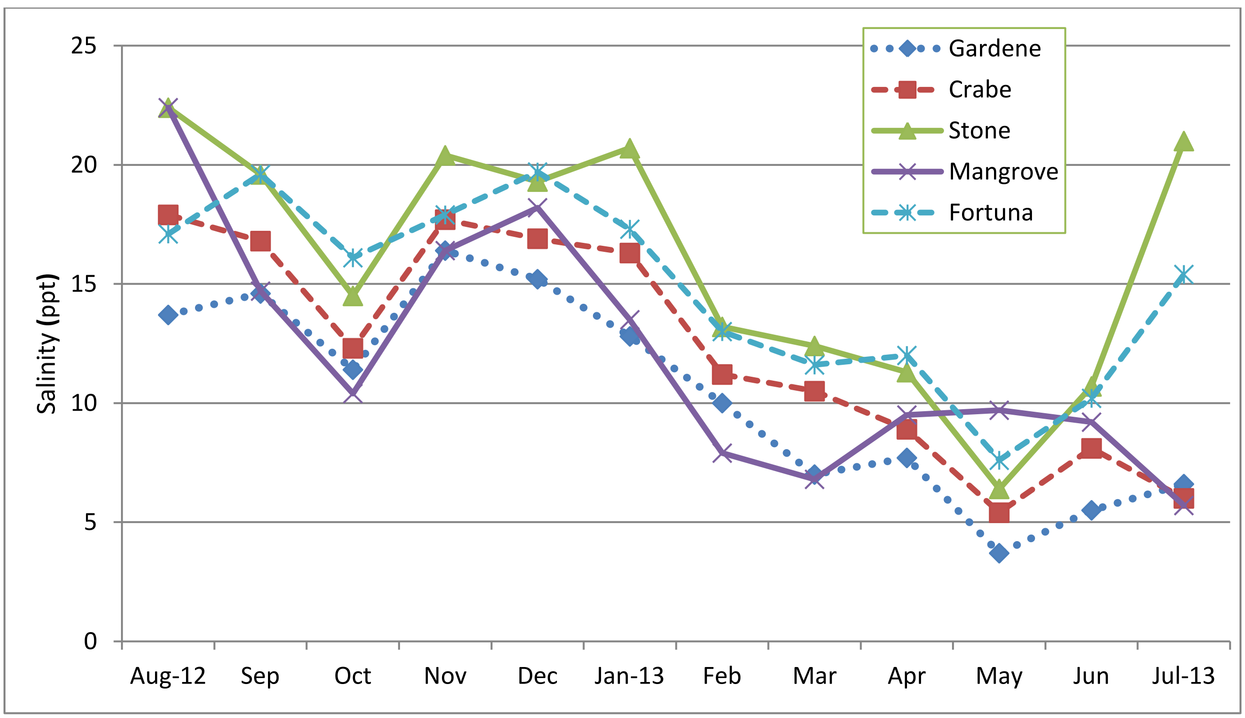


Figure 2.4. Salinities for the South Pontchartrain Basin Public Oyster Seed Grounds since 2012 Assessment. Data presented are from discrete measurements on each reef.

Hypoxia

The definition of hypoxia varies as it is based on the percent saturation of water by oxygen. This varies with temperature and amount of other solutes. For most environmental assessments in this area, hypoxia can be viewed as concentrations of dissolved oxygen below 3 milligrams per liter (mg/L). As oysters are a sessile species, reef systems can often be impacted by hypoxia in an estuarine setting. Within the Pontchartrain Basin estuary, the most common driver of hypoxia over reef systems is the stratification of the water column due to density differences in water masses. These density differences are oftentimes driven by salinity and temperature. Basically, warmer, fresher water overrides denser salt water and does not allow the diffusion of oxygen throughout the water column. This is common in areas that have experienced high fresh water inputs, especially after the return of higher salinity waters once fresh water inputs subside. In other cases, in relatively confined areas, increases in biological oxygen demand can also lead to hypoxia, although localized. Some instances of hypoxia are "usual" in most areas, but prolonged exposure can result in reduced growth, decreased disease resistance, or direct mortality. At the time of the 2013 assessment, only the California Bay area was experiencing a period of hypoxia as was evidenced by a dissolved oxygen measurement of 2.8 mg/L at Mangrove Pt. taken during this sampling event (Figure 2.5). The monthly average for this area, taken from weekly isohaline sampling data, was 4.8 mg/L.

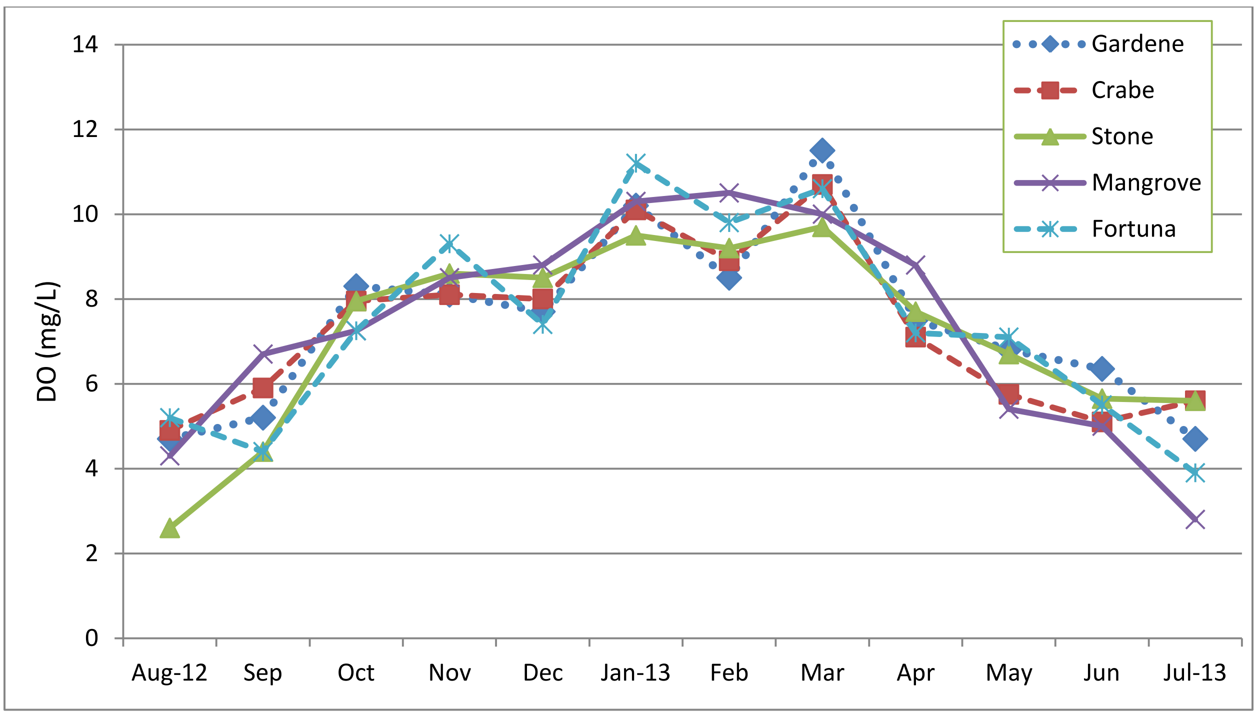


Figure 2.5 Dissolved oxygen levels for the South Pontchartrain Basin Public Oyster Seed Grounds since 2012 Assessment. Data presented are from discrete measurements on each reef.

Freshets

While freshets often provide benefits to the reef system, either by reducing disease or predation, or enhancing cultch opportunities, we must also realize that other variables are also operating at the same time. The impact/recovery are also modified by not only the magnitude of a freshet, but perhaps more important are the duration and timing. Specifically, this area has experienced two such events over the assessment period occurring during, or very near, peak spring spawning times.

Sedimentation/Subsidence

During periods of high freshwater input sedimentation over reefs can be a problem. This sedimentation can affect the reef either through direct mortality (burial) or through reduced growth and reproduction (both production and clean places for larval attachment). During the 2013 assessment, divers noted on several reefs that some of the cultch had a covering of silt and still others had buried cultch. Both of these conditions are known to limit the amount of suitable substrate available for larval settlement.

Subsidence of the reefs is usually balanced by reef accretion or growth. If no appreciable shell is added over a period of time, the reefs, especially those in less than optimal environments, will subside to the point of shell burial. The lowering of the reef profile also subjects associated organisms to more frequent hypoxia events as well as changing the local water flow and sedimentation processes.

Cultch Condition

Any successful spat set is dependent upon clean, stable cultch for larval attachment. The condition of the cultch and live oyster shell within the South Pontchartrain Basin currently appears to be poor. As noted above, many areas are buried or covered with a thin layer of silt. On some reefs within the Basin, the cultch is covered at least partially by fouling organisms such as Spionid polychaete mud tubes, ctenostome and fairy lace bryozoans, the tube dwelling amphipod, *Apocorophium*, and other small hydroids, all of which can pose hindrance to larval oyster settlement. In other areas, the addition of shell to a reef has become so infrequent that the cultch on hand is being transformed into small "hash" particles that do not provide optimal substrate for larval attachment.

<u>2012/2013 Oyster Season Summary</u>

The 2012/2013 oyster season on the South Pontchartrain Basin public oyster seed grounds opened on October 29, 2012 for the harvest of sack oysters exclusively. Seed oyster harvest was closed for the entirety of the 2012/2013 oyster season. This management decision was made in light of the extremely low abundance of seed oyster stock estimated during the 2012 Oyster Stock Assessment. The northern portion of South Pontchartrain Basin was kept closed until April 8, 2013 in an effort to protect a strong spat set in the Lake Fortuna area. Additionally, the Bay Gardene seed reservation remained closed to harvest. The 2012/2013 oyster season was closed on April 30, 2013.

Harvest Monitoring Methods

Fishing effort was observed on the South Pontchartrain Basin public oyster seed grounds during the 2012/2013 season by the following method: Harvest totals were estimated by obtaining fisheries dependent data from the monitoring of users. “Boarding Surveys” were conducted weekly during the season. LDWF Biologists survey the entire area observing fishermen, recording locations, and making harvest estimates for each vessel for that day. This estimate is projected over the amount of “fishable days” (winds less than 25 mph) for the week and a total harvest of seed and market oysters for the week is made. Vessels collecting seed are often boarded to determine if excessive amounts of cultch (non-living reef material) are being removed from area reefs. Harvest data is also obtained via the trip ticket system in place for this fishery. However, this data is consolidated by geographic region and is considered preliminary until well after the season concludes, and provide a limited resolution.

Harvest Results and Discussion

Harvest totals for market sized oysters in 2012/2013 were estimated at 5,586 sacks (2,793 barrels). When harvest estimates within stock-assessed areas are compared with the 2012 assessments, there was an estimated utilization of 20.6% of the sack resource, and 17.3% utilization overall. Harvest amounts as well as observed vessels were not constant over time. Sack harvest effort was distributed throughout the area, with a majority of harvest effort observed in the California Bay area and the northern portion of the basin, Lakes Machias and Fortuna, which opened later in the season. There was no documented harvest of seed oysters in the South Pontchartrain Basin, as the area was opened exclusively for sack oyster harvest. As there was no seed harvest during the season for this portion of the Basin, no cultch samples were taken during this assessment period.

Coastal Study Area 3 – Oyster Stock Assessment

<u>Introduction</u>

Coastal Study Area (CSA) 3 consists of three public oyster areas distributed generally in a north-south direction within the Barataria Bay estuary: 1) Little Lake Public Oyster Seed Grounds (POSG), 2) Hackberry Bay Public Oyster Seed Reservation (POSR), and 3) Barataria Bay Public Oyster Seed Grounds (POSG). Hackberry Bay is the oldest of the three as it was designated by the Louisiana Legislature as a public oyster seed reservation in 1944. Barataria Bay was designated by the Louisiana Wildlife and Fisheries Commission (LWFC) as a public oyster seed ground in 2000, and Little Lake was designated by the LWFC in 2007. Historically, CSA 3 has monitored three sampling sites for annual oyster stock assessment, all in Hackberry Bay. Sampling has expanded in recent years, however, with the addition of the Barataria Bay POSG, and the addition of newly constructed oyster reefs in Hackberry Bay.

Hackberry Bay (Jefferson/Lafourche Parishes) is a 4,402 acre mesohaline embayment with a primarily soft silt and clay bottom, of which only 14.7 acres is naturally occurring reef material. The three historical sampling sites within Hackberry Bay are the upper, middle, and lower Hackberry sampling sites. The middle Hackberry site is the only site located over existing natural reef, while the upper and lower sites are over former cultch plants placed on top of historical reefs. The upper Hackberry sampling site was the result of a 1994 cultch plant using federal disaster funds from Hurricane Andrew in 1992. The upper site had also been the location of cultch plants in 1943 (140 acres), 1945 (70 acres), 1946 (92 acres) and 1981 (67 acres). The 1994 cultch site was comprised of six different sections of substrate including: crushed concrete, shucked shell, reef shell, clam shell, Kentucky limestone and Bahamian limestone totaling 145 acres. The lower Hackberry sampling site is on a reef that was part of a 450 acre 1973 cultch plant. Since very little natural reef exists in the Hackberry Bay POSR, production is highly dependent upon and reflective of when and where cultch plants are placed in the bay. It is unknown how much, if any, cultch material from the 1994 and earlier cultch plants remains exposed above the surface of the mud. Therefore, the acreage of these cultch plants is not factored into the annual oyster stock assessment.

In response to impacts from Hurricane Lilly in 2002, two cultch plants were placed in Hackberry Bay in 2004. The 10 acre northern Hackberry Bay cultch plant was planted near the old 1994 cultch plant on May 10, 2004 using 2,322 cubic yards of limestone. The 25 acre southern Hackberry Bay cultch plant was planted between May 10 and 12, 2004 using 4,005 cubic yards of limestone.

In 2008, a cultch plant was placed in the northeastern portion of Hackberry Bay using federal funds dedicated to the impacts of Hurricanes Katrina and Rita. The 2008 cultch plant is approximately 50 acres in size and was planted between May 20 and 25, 2008 using approximately 75% limestone, 15% crushed concrete, and 10% cleaned oyster shell. The total volume of material deposited was 10,171 cubic yards.

On May 13 thru 21, 2012, utilizing early restoration funds following the BP oil spill, 26,086 cubic yards of limestone were placed on approximately 200 acres in the northwest portion of Hackberry Bay. This increased the estimated reef acreage on the Hackberry Bay POSR from 99.7 to 299.7 acres.

The Barataria Bay POSG was designated as a public oyster ground in response to possible changes in the salinity regime of the estuary stemming from the Davis Pond Freshwater Diversion project. Davis Pond is a large Mississippi River diversion project that aims to reintroduce freshwater and nutrients into the Barataria Bay estuary. As this new coastal restoration project was anticipated to reduce salinities in the estuary, LDWF felt that an additional public oyster seed ground farther down-estuary may be productive during years with high freshwater input. The only known existing reef in the Barataria Bay POSG is a 40-acre reef constructed in 2004. The reef is comprised of 7,536 cubic yards of crushed concrete. The Barataria Bay cultch plant was placed between May 6 to 8, 2004 and is located in the northeast section of the Barataria Bay POSG. It is vulnerable to predators such as oyster drills and the protozoan parasite *Perkinsus marinus* - (Dermo) during periods of higher salinities. Consistent production is not expected until salinity regimes in the basin change due to natural forces or coastal restoration efforts.

On February 1, 2007 the Wildlife and Fisheries Commission created the Little Lake POSG. Prior to 2004 this area had been utilized as a temporary natural reef area, and was once covered with private oyster leases. These leases all fell within the Davis Pond freshwater diversion impact area and were either purchased or moved by the state and federal government prior to the opening of Davis Pond. Davis Pond has not been consistently utilized to its maximum capacity since it first opened in 2002, and environmental conditions during some years have allowed oysters to continue to exist in Little Lake. Therefore, the LWFC designated this area a public oyster ground so that oysters could be harvested and reefs could be actively managed by LDWF. The location of the Little Lake POSG makes it vulnerable to freshwater inputs from rainfall, inflow from the Intracoastal Waterway, and discharge from the Davis Pond freshwater diversion. Reduced salinities from increased freshwater input can have a negative impact on oyster survival and availability. However, when higher salinities exist, the Little Lake POSG has provided the oyster industry with additional seed and sack oysters in the Barataria basin. Although very little information on reef acreage exists for Little Lake, LDWF hopes to better survey the area in the future.

Materials and Methods

Quantitative samples used in this assessment were collected by CSA 3 biologists on 2-3 July, 2013. Samples were obtained using a one square-meter (m^2) frame placed randomly on the bottom over reef at each sampling location. Using SCUBA, all live and dead oysters, as well as shell, in the upper portion (exposed) of the substrate were removed from the area within the frame. Live and dead oysters, fouling organisms, and oyster predators were identified and enumerated. All oysters were measured in five millimeter work groups and further classified by size as spat (0-24mm), seed (25-74mm), and sack oyster (75mm and greater). Seven stations were visited (Figure 3.1) with five replicate square meter samples taken at each location. The 2012 cultch plant in Hackberry Bay was also quantitatively sampled using five replicate ¼ m^2 samples taken at random locations. All live and dead oysters as well as substrate in the frame were removed by divers. Live and dead oysters, fouling organisms, and oyster predators were identified and enumerated. Oysters were measured and categorized by size groups. The average of the five replicates at each station was used, in combination with reef acreage, to estimate the current oyster availability for CSA 3. Each sample was also divided into live oysters, dead shell/cultch, and mussels so that estimates of reef mass (in grams) could be calculated for sustainable oyster shellstock (SOS) modelling purposes.

The Little Lake POSG was not sampled due to lack of reef acreage information.

Results and Discussion

Seed and Sack Stock

Stock for the Hackberry Bay POSR, including the 2004, 2008 and 2012 cultch plants, is estimated at 16,187 barrels (bbls) of seed size oysters and 5,104 bbls of market size oysters for a total of 21,291 bbls of overall stock. Seed were present at all stations except the 2004 Barataria Bay Cultch Plant. There was an overall 57% increase in seed availability from 2012. Seed availability is up 252% above the past 10 year average, and 12.5% above the long term average (1976-2012). Sack oysters were present at all stations with the exception of the Barataria Bay 2004 cultch plant. The Hackberry Bay 2012 cultch plant also had sack oysters available for the first time since it was planted (Figure 3.2). Including the Hackberry Bay 2012 cultch plant, sack stock was still down 47% from 2012, although 242 % above the past 10 year average, and 29% below the long term average (1976-2012) (Table 3.1, Figure 3.3). Combined stock showed an overall 17% decline compared to 2012, 249% above the 10 year average, but was 2.3 % below the long term average. Some of the combined stock reduction may be attributable to a decline in seed and sack oysters at the Hackberry Bay 2004 South Cultch Plant. The majority of this reef was covered in approximately six inches of mud and there was a 80% decline in abundance of sack oysters versus 2012. The monthly average size of seed and sack oysters, from combined dredge and square meter samples, was 2.7 inches, ranging from 1.21 to 2.94 inches (Figure 3.4 and 3.5). The overall average size from January 2012 to July 2013 was 2.57 inches (Figure 3.5). The July 2013 monthly average catch-per-unit-effort (CPUE) for both seed and sack oysters, as well as combined total, was lower than July 2012 and was also below the overall monthly average CPUE for dredge samples from January 2012 through June 2013 (Figure 3.6).

No live, seed or sack oysters were observed in the Barataria Bay (POSG) only live spat in 2 out of 5 samples (Figure 3.1, Table 3.1). Market-size oyster availability has not been documented on the Barataria Bay (POSG) since it was created in 2004.

Spat Production

Unlike the average catch of 34.3 spat per square meter seen in 2012 there were only 24 total spat sampled in 2013, which is well below the long term average since 1976 of (7.6 spat/square meter). The highest numbers were found at the Barataria Bay POSG with 13 of the 24 total spat coming from that reef, where alternatively in 2012 no live spat were observed. Since inception, the only stock assessments on the Barataria Bay POSG with a record of spat were in 2005 (8 spat per m^2), 2009 (53.5 spat per m^2), and 2010 (5.2 spat per m^2).

Fouling Organisms

The hooked mussel (*Ischadium recurvum*), is a reef-associated benthic bivalve species that competes with oysters for food and settlement surfaces. Hooked mussels were present at all sampling stations except in Barataria Bay POSG. Highest densities were observed at the Middle Hackberry Bay station (Table 3.2). The average number of hooked mussels observed in the Hackberry Bay POSR was $100/m^2$, primarily driven by the large increase in the average for the Middle Hackberry Bay site at 646 mussels per square meter. Two of the five replicate samples from Middle Hackberry contained large pieces of drill pipe with an abundance of hooked mussels attached. Disregarding those two samples still represents a substantial increase over last year's average of 31.2 per square meter and may be attributable to overall lower salinities in the Bay. Monthly average salinities in Hackberry Bay were below the long term average (LTA) for the five months from February through June 2013 prior to square meter sampling (Table 3.2, Figure 3.7).

Mortality

Recent spat mortality at each station on the Hackberry Bay POSR ranged from 0 to 50.0% with an overall average of 11.2 %. Recent seed oyster mortality at each station ranged from 0 to 6.4% averaging 0.9%. Recent mortality in sack-size oysters ranged from 0 to 7.6% with an overall average of 1.1% and a combined overall spat, seed, and sack mortality of 3.6% (Table 3.2).

No live or recently dead spat, seed, or market size oysters were observed on the Barataria Bay POSG.

Additional sources of oyster mortality data available since the 2012 oyster stock assessment include monthly dredge samples and the ongoing Nestier tray project which places oysters in trays at multiple stations throughout the Barataria basin. Dredge samples revealed an overall monthly mortality of 4.7% between July 2012 and June 2013, however, this number includes the elevated mortality of 24% observed in September 2012 after Hurricane Isaac (Figure 3.8). On August 29th 2012 Hurricane Isaac made landfall in Fourchon Louisiana, the southernmost portion of the Barataria Bay estuary, with maximum sustained winds of 80 miles per hour. Although

Isaac was a Category 1 storm it was considered large for that category and produced a significant storm surge that may have contributed to some of the siltation on the Hackberry Bay 2004 south cultch plant. No other tropical systems have affected the study area since Tropical Storm Lee in 2011. Nestier tray mortality data is recorded from the on a monthly basis over the course of a year. By the end of June 2012, oyster mortality on the Nestier trays placed in Hackberry Bay in January 2012 was 43.8%. One hundred percent mortality was observed at the Middle Bank Light station adjacent to the Barataria Bay POSG and approximately 6 miles from Hackberry Bay POSR. High numbers of predation by oyster drills have been reported at the Middle Bank Light Station and most likely contribute to the high percent mortality at that station. A cumulative average mortality of 62.6% was observed for 9 of the 12 other Nestier tray stations throughout the basin.

Oyster Predators

The southern oyster drill (*Stramonita haemastoma)* is a predatory marine snail that feeds on oysters and other sessile organisms using a radula (a small tooth-like rasping organ) to bore a hole through the shell. During the 2012 stock assessment only five snails were observed at the Barataria Bay POSG, however, during the 2013 stock assessment no snails were observed at any of the sampling stations. Since 2009 only 18 oyster drills have been sampled during dredge and square meter sampling and most of those have come from the Barataria Bay POSG. Mortalities of oyster drills have been reported from Mississippi Sound when salinities fell to 8-10 parts per thousand (ppt), therefore, the absence of oyster drills from 2013 samples is most likely due to the low overall average salinities throughout the basin beginning in January (Figure 3.9).

Tropical and Climatic Events

The United States Army Corps of Engineers (USACE) Tarbert gauge recorded Mississippi River discharge from January through June 2013 as above the long term average (1961-2010) of 665,000 cubic feet per second (cfs), and reaching a peak discharge of 947,000 cfs. in May 2013. Discharge levels remained above the average in June at 811,000 cfs prior to our sampling effort in July 2013 (Figure 3.9).

The United States Geologic Survey (USGS) constant data recorder, located near the Davis Pond diversion structure, recorded a monthly average rise above the long term monthly average of 1,831cfs in January 2013. This coincided with the rise in discharge of the Mississippi River and reached 3,766 cfs on the Davis Pond gauge. Average monthly discharge rates were above the long term average (2003 to 2010) from January through June 2013 (Figure 3.10).

Hackberry Bay POSR salinities from January 2012 to June 2013 averaged 10.7 parts per thousand (ppt) with a range of 4.3 to 19.6 ppt (Figures 3.7, 3.9, & 3.10). The average for June 2012 was 11.6 ppt which remained slightly above the 1996 to 2011 June long term monthly average of 10.98 ppt.

Salinities in the Barataria Bay POSG from January 2012 to June 2013 averaged 20.5 ppt with a range of 12.6 to 28.6 ppt (Figure 3.9 and 3.10).

Salinities in the Little Lake POSG from January 2012 to June 2013 averaged 4.6 ppt with a range of 1.2 to 11.6 ppt (Figure 3.9 and 3.10).

Non-Climatic Events

Areas around Bay Jimmy, Grand Terre and the mouth of the Mississippi river remain closed to oyster harvest due to impacts from the BP MC252 oil spill. Natural Resource Damage Assessment (NRDA) efforts to determine the effects of the spill on oyster resource throughout the area are ongoing.

2012/2013 Oyster Season Summary

The Little Lake Public Oyster Seed Grounds opened on September 5, 2012 and closed on April 30, 2013. The opening of the 2012/2013 harvest season in the Hackberry Bay POSR and Barataria Bay POSG occurred on October 29th, 2012. The Hackberry Bay seed grounds remained open for 5 days closing on November 3, 2012, with the sack harvest closing on November 18th. Total harvest from public grounds in CSA 3 during the 2012/2013 season was estimated at 2,517 bbls of seed oysters with a 23.9% utilization of assessed resource and 5,151 sacks having 23.3% utilization. All seed and sack harvest was observed from Hackberry Bay. (Table 3.3). Using the Sustainable Oyster Shellstock (SOS) model for Hackberry Bay provided a theoretical threshold of 3500 harvestable barrels of seed and the harvest of 2,517 barrels was 71.9% of that threshold. The SOS model for Hackberry Bay also provided a theoretical threshold of 4700 sacks of harvestable market oysters, and 5,151 sacks were harvested during the open season, totaling 109.6% of the model threshold.

The removal of reef material from public reefs when bedding has long been a concern to LDWF biologists. The practice threatens the long-term sustainability of the oyster resource on the public grounds. To assess the amount of reef material being removed, three random samples from each vessel were collected and a subsample of each was measured using a one cubic foot aluminum container. In each subsample, any material having live seed or sack oysters was separated from material without live oysters. Large clusters were culled. The percentage of cultch removed was calculated by dividing the weight of the material without seed or sack oysters by the total weight of the material contained in the cubic foot container. Data from the three samples were averaged to obtain a percent cultch estimate for each vessel.

Seven vessels were boarded and samples taken to determine the percent of non living reef material removed from the reefs. The average percent for each vessel ranged from 0.6 to 24.5%. The overall average of cultch removed was 15.1%.

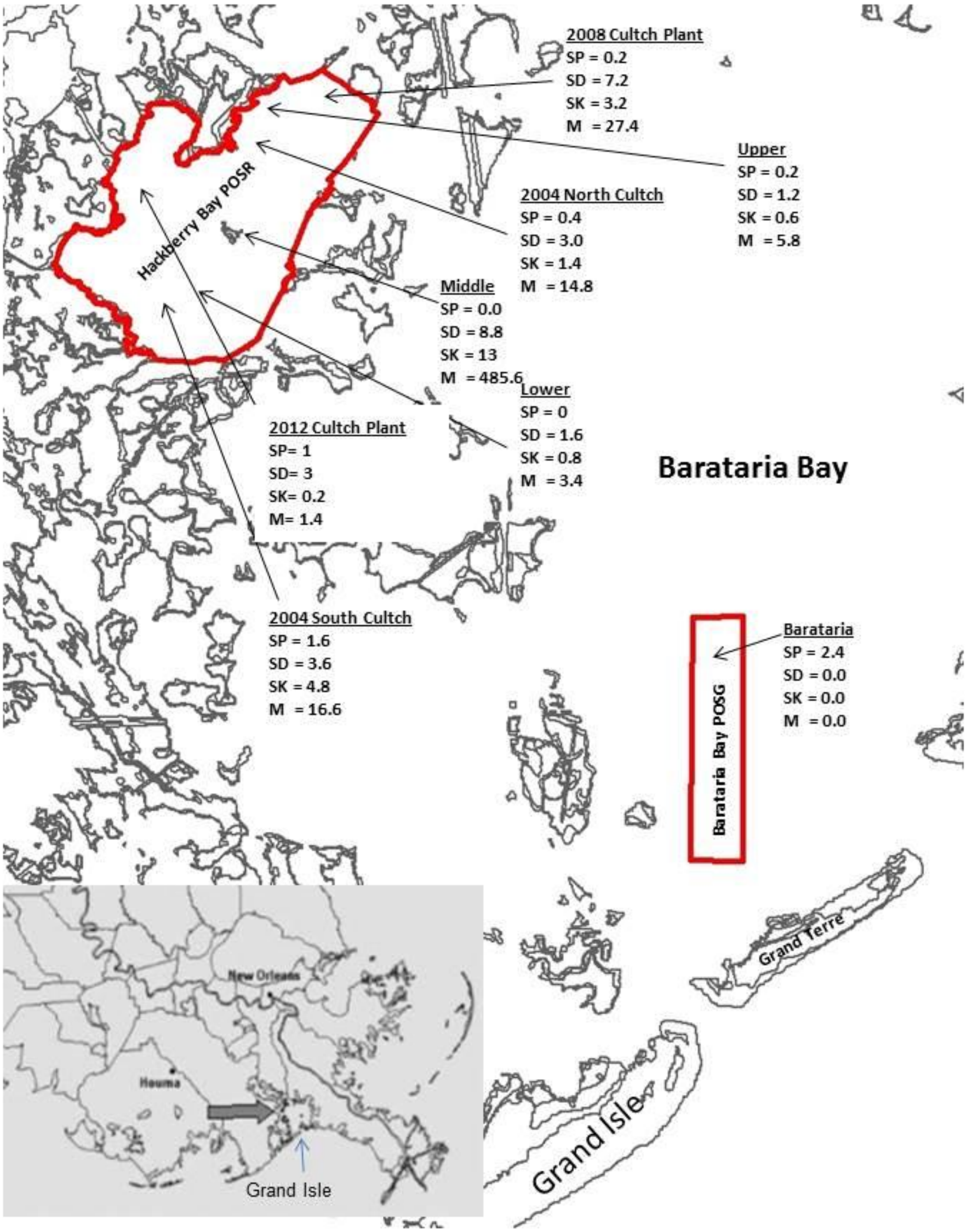


Figure 3.1 Map showing 2013 Hackberry Bay POSR and Barataria Bay POSG sample results as an average per square meter (SP=Spat, SD=Seed, SK=Sack, and M=Mussels).

Table 3.1 2013 square meter results for the Barataria Basin (CSA 3).

Station	No.	Approx Reef Acres	Average Live Seed Oysters / M2	Average Live Sack Oysters / M2	Barrels of Seed Available	Barrels of Sack Available	Oyster Spat/M2
Hackberry Bay 2004 North Cultch Plant	6	10	3.0	1.4	168.6	157.4	0.4
Hackberry Bay 2004 South Cultch Plant	7	25	3.6	4.8	505.9	1,349.0	1.6
Hackberry Bay 2008 Cultch Plant	9	50	7.2	3.2	2,023.4	1,798.6	0.2
Hackberry Bay 2012 Cultch Plant	10	200	12	0.8	13,489.5	1,798.6	1.0
Lower Hackberry Bay	1	4.9	1.6	0.8	44.1	44.1	0.0
Middle Hackberry Bay	2	4.9	8.8	13.0	242.4	716.1	0.0
Upper Hackberry Bay	3	4.9	1.2	0.6	33.0	33.0	0.1
Barataria Bay 2004 Cultch Plant	8	40	0.0	0.0	0.0	0.0	2.4
Little Lake		Unknown	Unknown	Unknown	Unknown	Unknown	
Totals		339.7			16,506.9	5,896.8	

	2012	2013	% Change
Seed	10,512.8	16,506.9	+57%
Sack	11,045.9	5,896.8	-47%
Total	21,558.7	22,403.7	+4%

Table 3.2 2013 square meter predator/mortality results for the Barataria Basin (CSA 3).

Station	Station No.	Hooked Mussels/m^2	Oyster Drills Present	Spat Percent Mortality	Seed Percent Mortality	Sack Percent Mortality	Seed & Sack Percent Mortality	All Size Percent Mortality
Hackberry Bay 2004 North Cultch Plant	6	15	0	0	0	0	0	0
Hackberry Bay 2004 South Cultch Plant	7	17	0	0	0	0	0	0
Hackberry Bay 2008 Cultch Plant	9	11	0	0	0	0	0	0
Hackberry Bay 2012 Cultch Plant	10	0	0	29	0	0	0	9
Lower Hackberry Bay	1	3	0	0	0	0	0	0
Middle Hackberry Bay	2	646	0	0	6	9	8	8
Upper Hackberry Bay	3	6	0	50	0	0	0	9
Barataria Bay 2004 Cultch Plant	8	1	0	N/A	N/A	N/A	N/A	N/A
Little Lake		N/A						

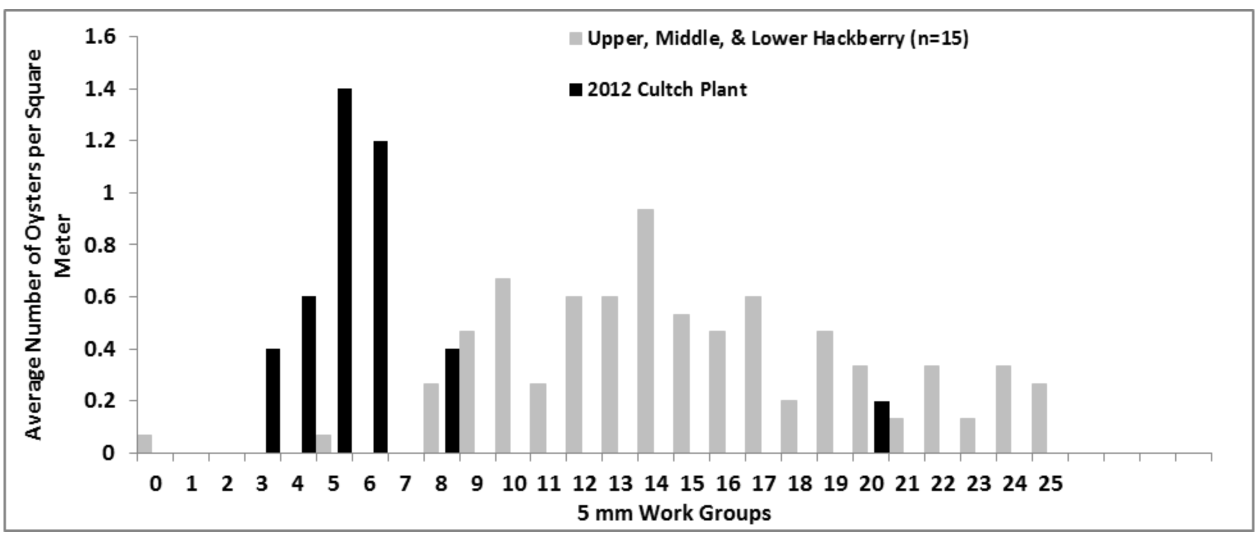


Figure 3.2 Oyster size-distribution by 5 mm work groups in historic square meter samples compared to those collected from the 2012 Hackberry Bay Cultch Plant in 2013.

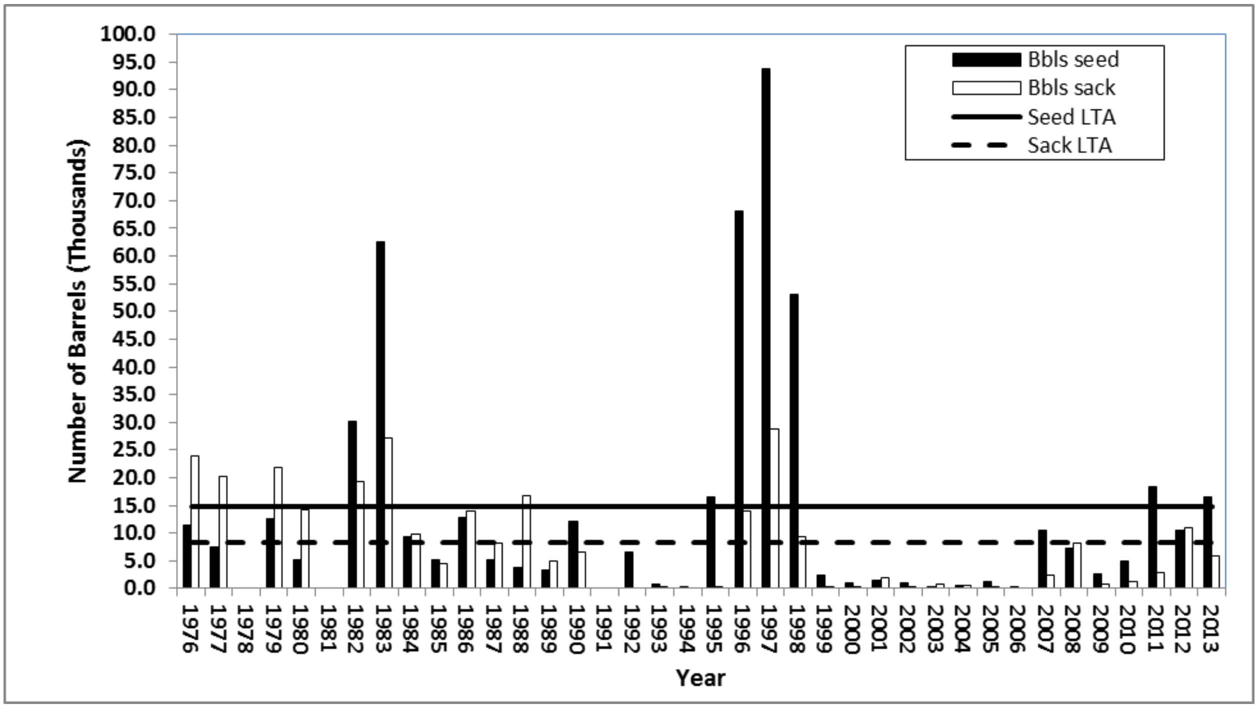


Figure 3.3 Estimated seed and sack oyster availability in the Hackberry Bay POSR from 1976 to 2013 compared to long term average seed and sack abundance.

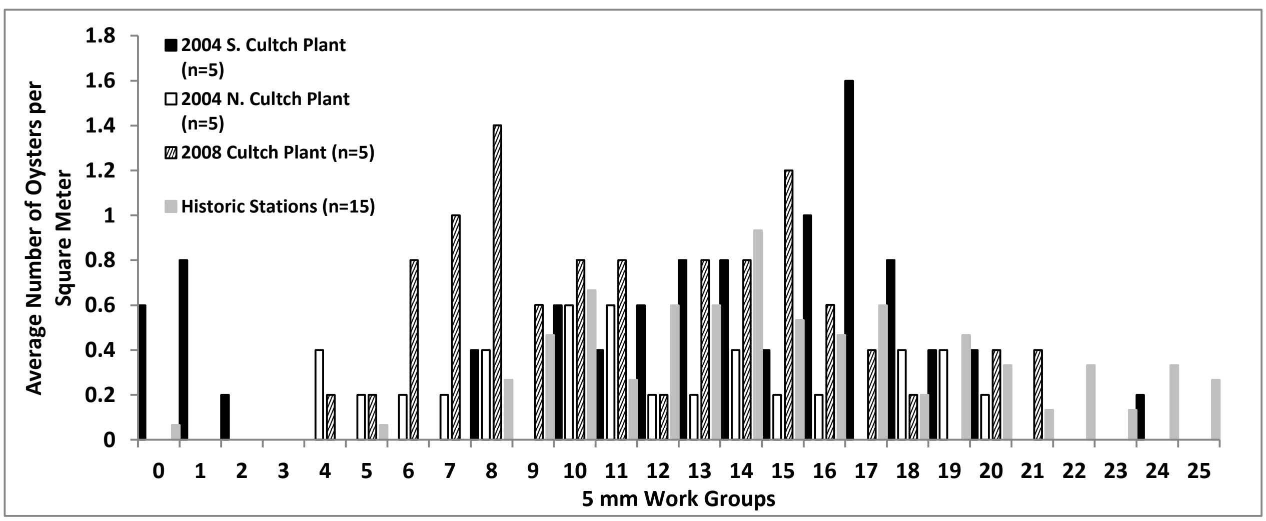


Figure 3.4 Oyster size distribution by 5 mm work groups in square meter samples collected from the Hackberry Bay POSR during 2013.

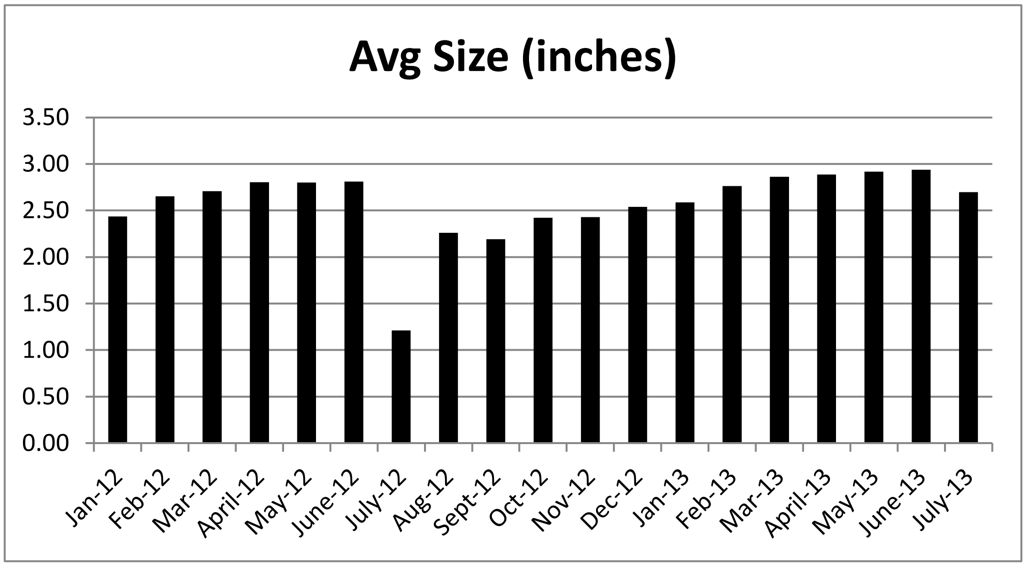


Figure 3.5 Monthly average oyster size for dredge samples and square meter samples (July 2012/2013).

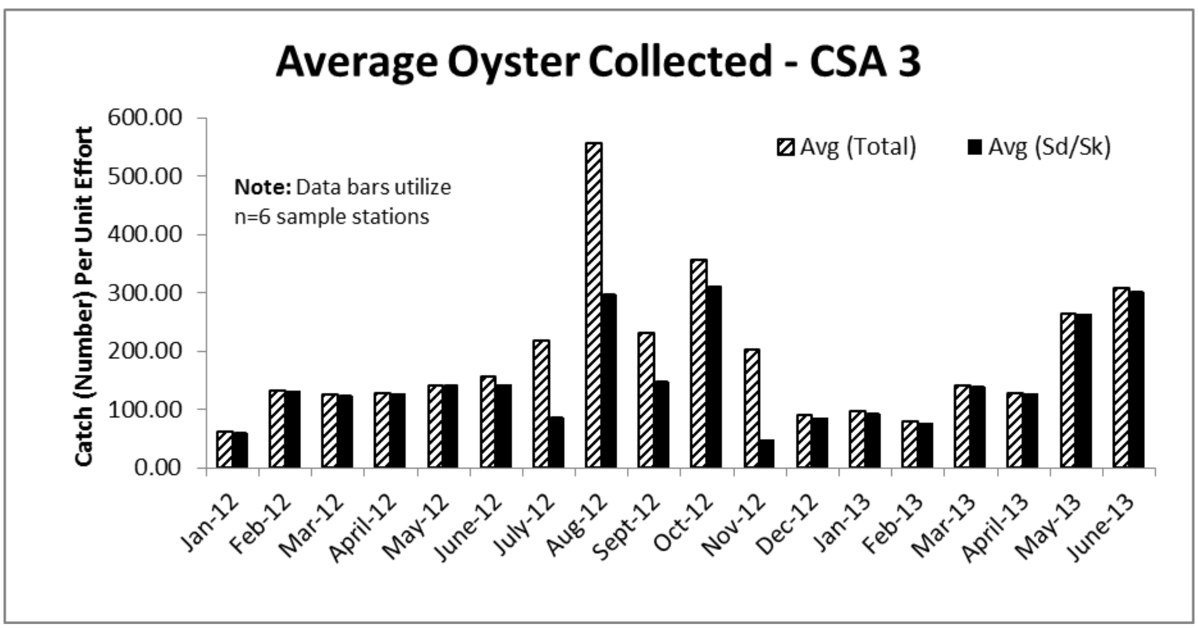


Figure 3.6 Monthly Catch per Unit Effort (CPUE) for dredge samples.

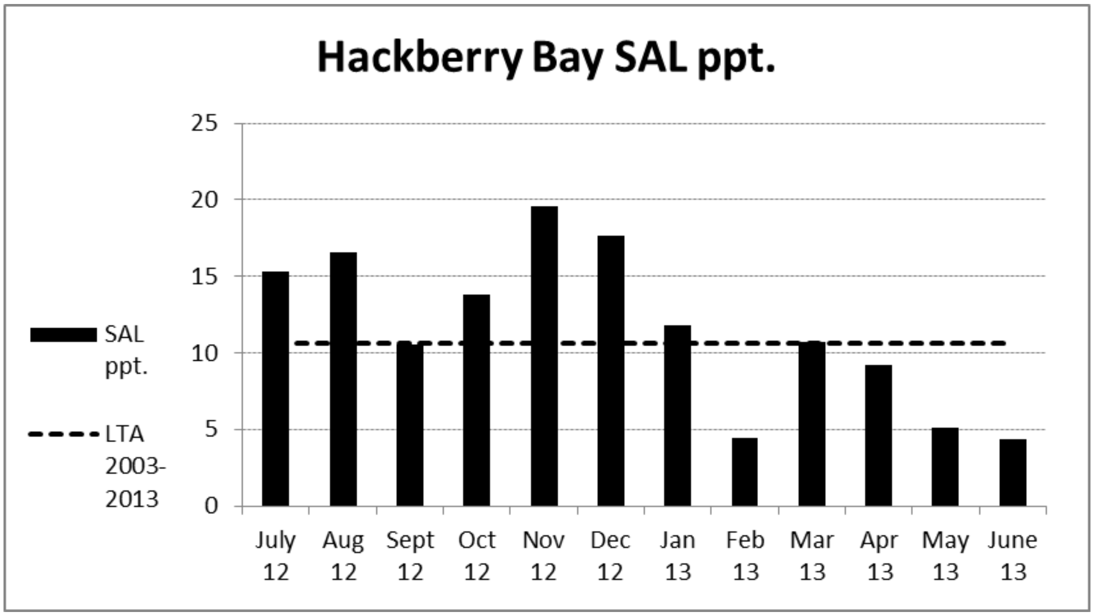


Figure 3.7 Long-term average monthly salinity in Hackberry Bay from 2003-2013 and monthly salinities during the July 2012-June 2013 time period. Data supplied by the United States Geological Survey (USGS) constant data recorder located in Hackberry Bay.

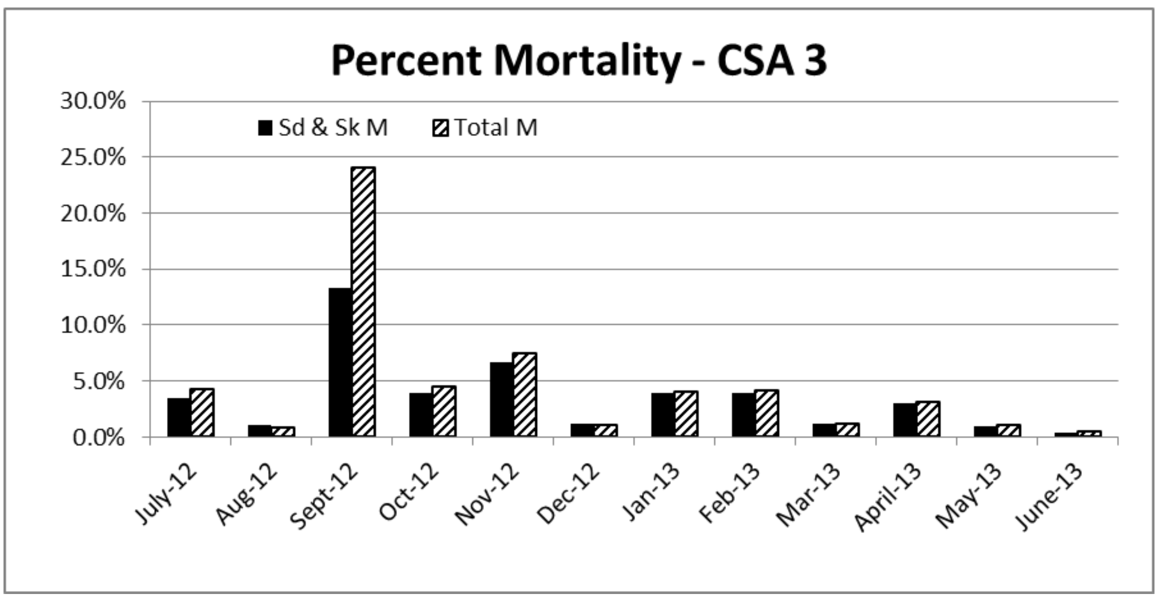


Figure 3.8 Overall oyster percent mortality and seed/sack combined.

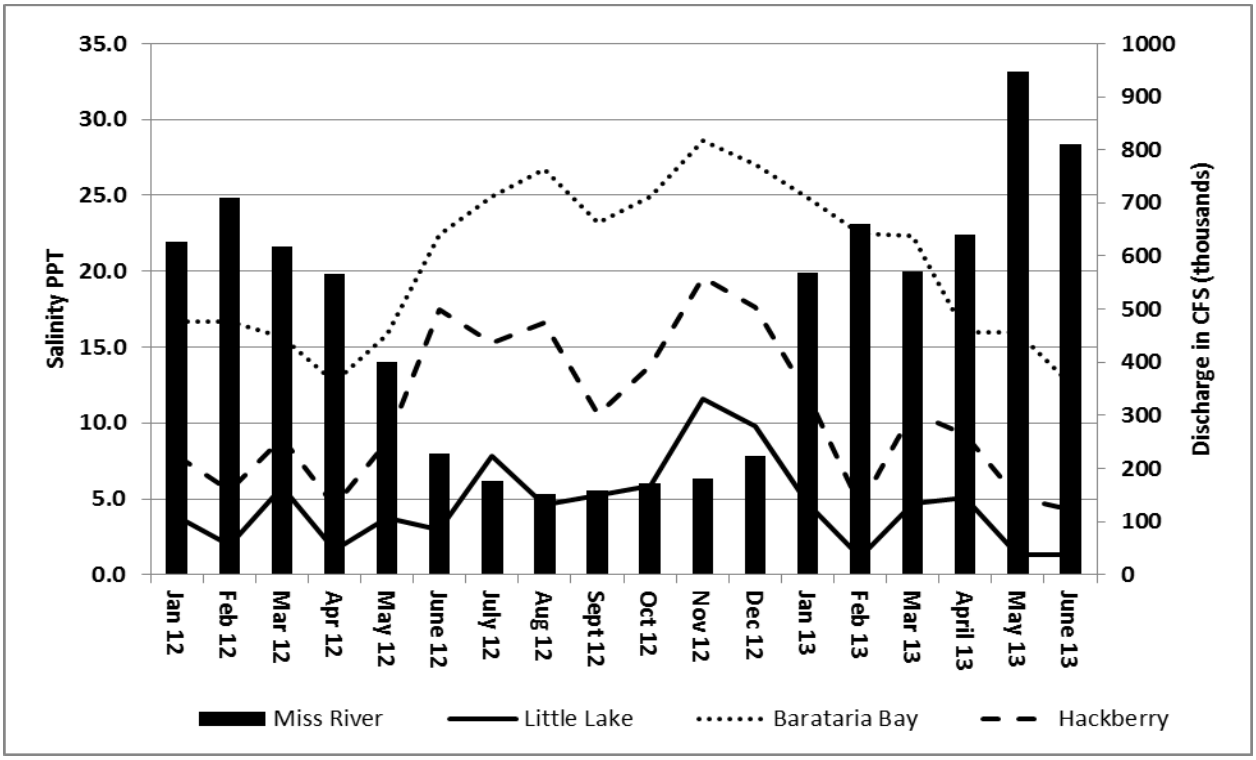


Figure 3.9 Mississippi River discharge vs. average monthly salinities in the Barataria Bay POSG, Little Lake POSG and Hackberry Bay POSR. River discharge data supplied by the U.S. Army Corps of Engineers (USACE), and salinity data supplied by the U.S. Geological Survey (USGS).

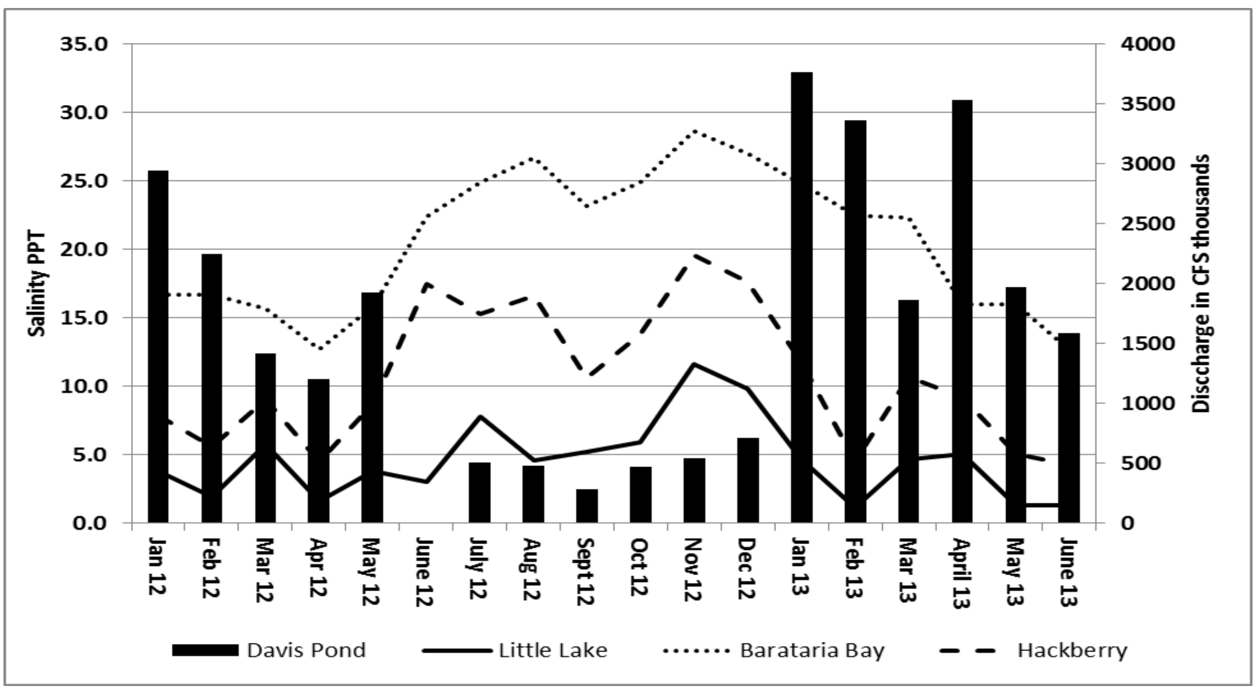


Figure 3.10 Davis Pond discharge vs. average monthly salinities in the Barataria Bay POSG, Little Lake POSG and Hackberry Bay POSR. Both discharge and salinity data supplied by the U.S. Geological Survey (USGS).

Table 3.3 Estimates of oyster harvest from the public oyster areas in Coastal Study Area 3 for the six past oyster seasons.

Public Oyster Area	**Seed Oysters Harvested (BBLS)**	**Sack Oysters Harvested (Sacks)**
Hackberry Bay POSG	2,517	5,151
Little Lake POSG	0	0
Barataria Bay POSG	0	0
2011/2012 *CSA 3 Totals*	1,634	29
2010/2011 CSA 3 Totals	*0*	*0*
2009/2010 CSA 3 Totals	*7,885*	*504*
2008/2009 CSA 3 Totals	*1,985*	*3,270*
2007/2008 CSA 3 Totals	*13,930*	*976*
2006/2007 CSA 3 Totals	*12,190*	*6,091*

Coastal Study Area (CSA) 5 – 2013 Oyster Stock Assessment

Introduction

The Terrebonne Basin (TB) includes that area from Bayou Lafourche west to the Atchafalaya River, and includes Terrebonne Bay and Timbalier Bays, Sister Lake, Lake Mechant, and Caillou Bay. Assessments are grouped into the eastern and western portions of the TB for presentation purposes.

There are currently eight different Public Oyster Seed Reservations (POSR) or Public Oyster Seed Grounds (POSG) within the Terrebonne Basin; these include Sister Lake (Caillou Lake) POSR, Bay Junop POSR, Lake Mechant POSG, Deep Lake POSG, Lake Felicity POSG, Lake Chien POSG, and Lake Tambour POSG. Sister Lake, Bay Junop, and Lake Mechant are located in the western TB while Deep Lake, Lake Felicity, Lake Chien, and Lake Tambour are found in the eastern TB (Figures 5.1 and 5.2).

Sister Lake (Caillou Lake) (Figure 5.1) was designated as a POSR in 1940 and includes 9,150.5 acres of water bottoms. The first known cultch deposition projects were established here between 1906 and 1909 by the U.S. Bureau of Fisheries. Subsequent plantings by the State of Louisiana began in Sister Lake in 1917; since then 21 cultch plants totaling 4,862.5 acres have been constructed, with some cultch plants being located on top of older ones or on top of existing reef habitat. Recent Sister Lake cultch deposition projects included a 67- acre site in 2004, a 156- acre site in 2009, and a 364.8- acre site in 2012. The 2012 cultch plant was originally designed to encompass 350 acres; however some additional material was placed on the southern end of the plant during construction, increasing the acreage to 364.8. The majority of the 2012 cultch plant was placed atop existing reef and made a minimal addition, less than 100 acres, to the total available reef acres in Sister Lake. The current total reef acreage for Sister Lake is estimated to be 2,375.36 acres.

The Bay Junop POSR (Figure 5.1) was established in 1948 and consists of approximately 2,646.5 acres of water bottoms. Due to the shallow water depth of the bay and inability of barges and tugs to enter for cultch deposition, no reef-building projects have been implemented in this area to augment natural oyster reef production. Available public reef acreage in this bay is estimated at approximately 252 acres.

The Lake Mechant POSG (Figure 5.1) was designated in 2001 with approximately 2,100 acres of water bottoms. In 2004, a 30 acre cultch plant was established. In 2007, un-leased water bottoms between the POSG and private oyster leases were added, increasing water bottom acreage within the public oyster seed ground to 2,583 acres. The total reef acreage outside of the 2004 cultch plant remains unknown.

The Lake Tambour, Lake Chien, Lake Felicity, and Deep Lake POSGs (Figure 5.2) were established in 2001. The upper portion of Lake Felicity was used as a public seed reservation during the 1940s and early 1950s, but was discontinued because salinities were usually too high for oyster production. However, future planned coastal freshwater diversion projects may return the area to a more favorable salinity regime for oyster production.

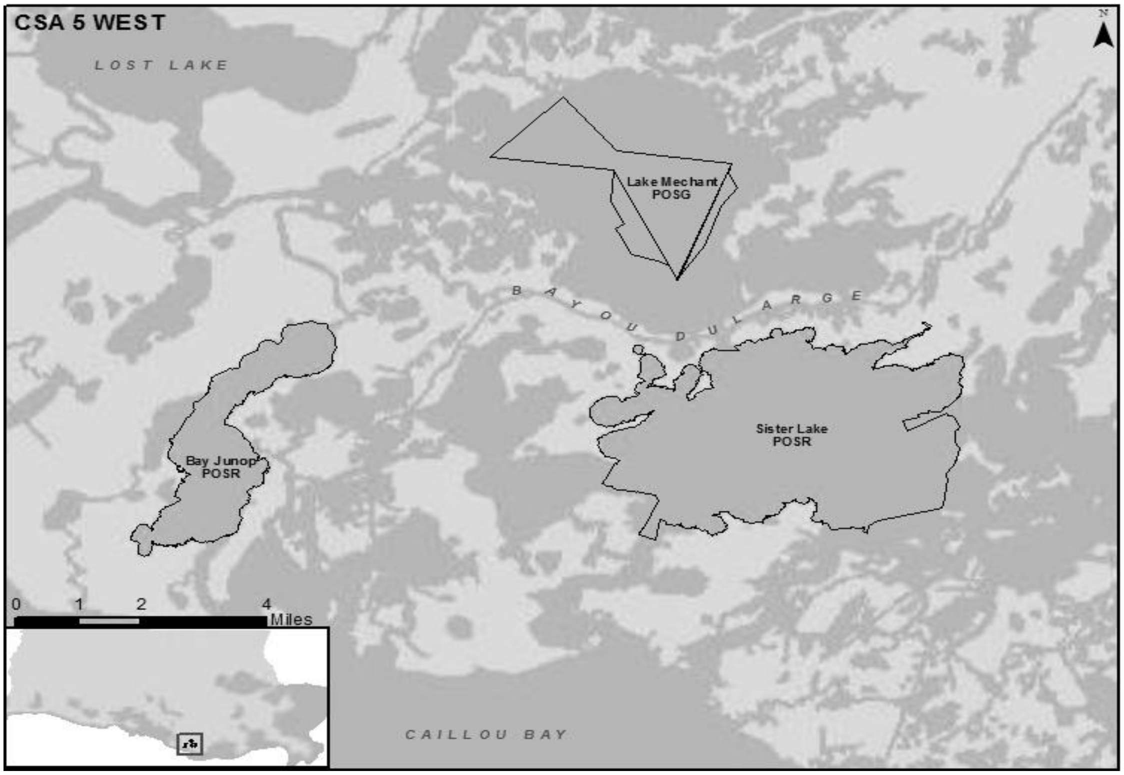


Figure 5.1 Public oyster areas within the western portion of Coastal Study Area (CSA) 5.

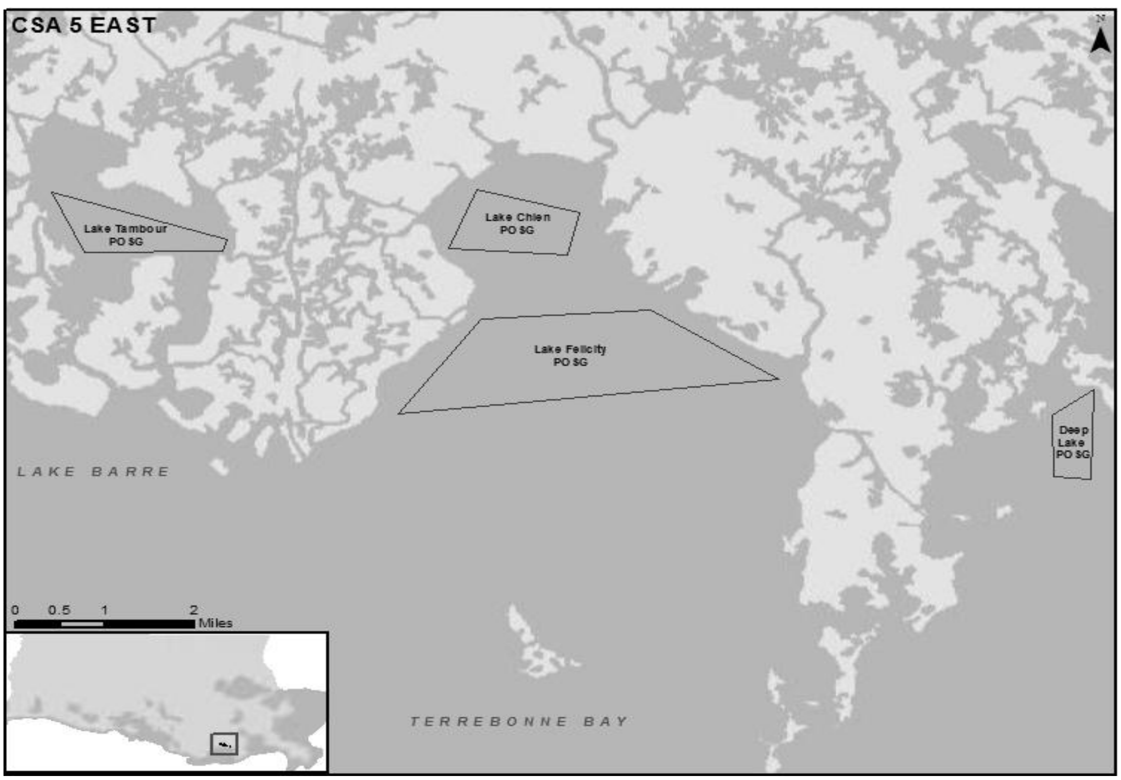


Figure 5.2 Public oyster areas within the eastern portion of Coastal Study Area (CSA) 5.

Lake Chien and Lake Felicity POSGs together have three cultch plants. Cultch deposition projects in Lake Chien (15.5 acres) and Lake Felicity (40 acres) were completed in the summer of 2004. Another 22.3 acre cultch plant was created in Lake Chien in May 2009 due east of the initial Lake Chien cultch plant. Outside of these cultch plants, there is no known reef in these areas and no reef development projects have been implemented in Lake Tambour or Deep Lake.

Materials and Methods

Square-meter field samples were collected on July 2, 2013 on existing oyster reefs in Lake Felicity and Lake Chien. Sampling was conducted at Sister Lake, Bay Junop, and Lake Mechant on July 9 – 10, 2013.

SCUBA divers collected five replicate samples at each station using an aluminum square meter frame that was tossed randomly over the reef. All oysters, loose shell and other organisms were removed from the upper portion of the substrate. Live and dead oysters, oyster predators, and hooked mussels (*Ischadium recurvum*) were separated and counted. Oysters were measured in 5 millimeter (mm) size groups and subsequently divided into three categories: spat (<25 mm), seed (25-74 mm), and sack (75 mm and larger) oysters. In conjunction with square meter oyster samples, water temperature and salinity data were also collected.

The average number of seed and sack oysters per square meter sample at each station was used to estimate oyster stock availability by extrapolation using known reef acreage. The footprint of the 2012 cultch plant, along with the combining of stations on overlapping reefs, resulted in an adjustment of acreage for the 2013 assessment. Specifically, stations 202 and 216 were associated with station 200 and the sample data averaged together as a reef complex. Station 217 was not sampled this year due to it being located beneath the 2012 cultch plant. Data from the cultch plant sampling was utilized to estimate oyster abundance on the cultch plant acreage only. The portion of the remaining acreage located within the reef complex, but outside of the cultch plant boundaries, was associated with station 214. For comparison purposes, 2012 oyster abundance and availability estimates for Sister Lake have been recalculated within this year's stock assessment to reflect the reef acreage adjustment.

Results and Discussion

Resource Availability

The overall 2013 estimated resource availabilities in the Terrebonne Basin POSGs and POSRs are 27,392 barrels of seed oysters and 38,073 barrels of sack oysters in the western basin (Sister Lake, Bay Junop, and Lake Mechant), and 189.9 barrels of seed oysters and 440.2 barrels of sack oysters in the eastern basin (Lake Felicity and Lake Chien) (Tables 5.1 – 5.3).

Average number of oysters per square meter sample station ranged from 0 to 7.8 for seed sized, and 0 to 10 for sack sized oysters (Figures 5.3 - 5.5). All estimates of seed and sack oyster resource availability in 2013 were below long-term historic means (Figures 5.6 - 5.10). In Sister Lake, the most productive oyster area in the Terrebonne Basin, estimated 2013 seed and sack oyster availabilities were 82% and 70% below long-term means, respectively, but remained relatively unchanged from 2012 estimates (Table 5.4). In the eastern basin, Lakes Chien and Felicity's oyster resource availability was 98% below long-term means for seed and 79% below long-term means for market oysters.

Spat Production

Average number of oyster spat ranged from 0 to 12.4/sample in 2013 (Table 5.5). Bay Junop had the highest number per sample and was the only area to show an increase from 2012. There were no spat present in samples collected from Lake Felicity or Lake Mechant. Of stations containing spat for the 2013 assessment, the Sister Lake 2012 cultch plant showed the largest decrease (91%) from 2012; the remaining Sister Lake stations showed an average decline of 53%.

Table 5.1 2013 Sister Lake oyster availability by sample station.

METER² STATION	REEF ACREAGE*	#METER²	#SEED OYSTERS	#SACK OYSTERS	BARRELS SEED OYSTERS	BARRELS SACK OYSTERS	OYSTER SPAT/m^2
200	320.31	1,296,294.57	2.4	5.3	4,320.98	19,084.34	1.3
203	140.43	568,320.21	0	0	0	0	0.2
207	55.77	225,701.19	5	0.8	1,567.37	501.56	10.8
213	191.04	773,138.88	0.4	2.4	429.52	5,154.26	0
214	552.44	2,235,724.68	0	0.4	0	2,484.14	0
215	512.79	2,075,261.13	0	0	0	0	0
218	82.26	332,906.22	7.4	3.2	3,421.54	2,959.17	11.0
219	155.52	629,389.44	7.8	3.8	6,818.39	6,643.56	0.2
2012 CP	364.8	1476345.6	4.8	0	9,842.30	0	2.4
TOTAL	2,375.36	9,613,081.92	27.8	15.9	26,400.10	36,827.01	

*See discussion in *Materials and Methods* section above.

Table 5.2 2013 Bay Junop Oyster Availability

METER² STATION	REEF ACREAGE	#METER²	#SEED OYSTERS	#SACK OYSTERS	BARRELS SEED OYSTERS	BARRELS SACK OYSTERS	OYSTER SPAT/m^2
251	17.20	69,608.40	2.8	3.6	270.70	696.08	0
252/255	67.36	272,605.92	1.4	0.4	530.07	302.90	24.7
253	73.26	296,483.22	0.3	0.3	123.53	247.07	0
TOTAL	157.82	638,697.54	4.5	4.3	924.30	1,246.05	

Table 5.3 2013 Lake Mechant/Lake Chien/Lake Felicity Oyster Availability

METER² STATION	REEF ACREAGE	#METER²	#SEED OYSTERS	#SACK OYSTERS	BARRELS SEED OYSTERS	BARRELS SACK OYSTERS	OYSTER SPAT/m^2
Lake Mechant	30.0	121,410.00	0.4	0	67.45	0	0
Lake Felicity	40.0	161,880.00	0.2	0	45.0	0	0
Lake Chien 2009	22.3	90248.10	0.6	1.2	75.2	300.8	9.4
Lake Chien 2004	15.5	62,728.50	0.8	0.8	69.7	139.4	7.0
TOTAL	107.8	436,266.60	2.0	2.0	257.35	440.2	

Table 5.4 Oyster availability and percent change from the 2012 to 2013 assessment for both regions of Coastal Study Area (CSA) 5.

		Barrels of Seed Oysters			Barrels of Sack Oysters		
Region	Area	2012	2013	*Change*	2012	2013	*Change*
Western TB	Sister Lake*	27,513.6	26,400.1	4%	34,113.5	36,827.0	8%
	Bay Junop	614.4	924.3	50%	1,651.4	1,246.0	25%
	Lake Mechant	6,239.1	67.5	99%	0.0	0.0	0
Eastern TB	Lake Chien	1,652.3	144.9	91%	1,059.0	440.2	58%
	Lake Felicity	2,158.4	45.0	98%	89.9	0.0	100%

* 2012 oyster availability estimates for Sister Lake were adjusted during the 2013 assessment to account for the change in reef acreage utilized for 2013 calculations, due to the 2012 cultch plant being established prior to the 2012 sampling event. Therefore, Sister Lake numbers presented in this table for 2012 will not match those published in the 2012 oyster stock assessment report.

Table 5.5 Average oyster spat per square-meter sample for the 2012 and 2013 assessment, for all areas within Coastal Study Area 5. (TB= Terrebonne Basin)

		Oyster Spat/m^2	
Region	Area	*2012*	*2013*
Western TB	Sister Lake	5.1	2.4
	2012 Cultch Plant	27.2	2.4
	Bay Junop	3.5	12.4
	Lake Mechant	19.4	0.0
Eastern TB	Lake Chien	15.3	8.2
	Lake Felicity	26.2	0.0

Hydrological Data

Mean water temperatures, for May and June 2013, on each public oyster area ranged from 25.2 - 28.1 C^o and were below the long-term means. Mean salinities were below average across the Terrebonne Basin for the two months prior to sampling (Tables 5.6 and 5.7). Temperature and salinity measurements collected concurrently with the square-meter sampling in July averaged: 28.4 C^o and 12.5ppt in the eastern basin, 28.7 C^o and 11.7ppt in Sister Lake, 27.8 C^o and 12.4ppt in Bay Junop, and 28.0 C^o, 4.7ppt in Lake Mechant.

Table 5.6 Mean May-June and historic means (excluding 2013) of water temperature (°C) and salinity (ppt) from Sister Lake, Bay Junop, and Lake Mechant dredge samples (X= not designated as seed ground or reservation and, thus, no data were collected).

	TEMPERATURE			SALINITY		
YEAR	Sister Lake	Bay Junop	Lake Mechant	Sister Lake	Bay Junop	Lake Mechant
1996	29.4	29.3	X	17.2	18.2	X
1997	29.0	28.8	X	7.7	10.1	X
1998	29.0	28.8	X	10.5	8.6	X
1999	28.2	27.5	X	14.1	13.4	X
2000	29.6	29.2	X	24.9	23.8	X
2001	27.5	27.5	X	12.1	14.0	X
2002	28.4	27.9	X	11.0	11.4	X
2003	29.1	28.9	X	7.5	9.2	X
2004	29.4	28.7	X	14.1	17.2	X
2005	28.3	27.9	X	16.1	19.0	X
2006	28.1	26.1	X	22.7	20.4	X
2007	27.6	27.5	27.8	19.3	20.0	11.5
2008	26.7	28.1	28.1	6.2	6.9	0.4
2009	29.5	29.1	28.6	10.3	12.0	2.6
2010	29.8	28.3	28.9	17.8	15.4	15.1
2011	26.4	26.5	25.7	16.1	16.1	5.5
2012	29.3	29.3	29.0	16.5	17.7	9.4
2013	28.1	27.8	27.8	9.3	11.0	1.9
Mean	28.5	28.2	28.0	14.4	14.9	7.4

Table 5.7 Mean May-June and historic means (excluding 2013) of water temperature (^{o}C) and salinity (ppt) from Lake Felicity and Lake Chien dredge samples.

YEAR	TEMPERATURE		SALINITY	
	Felicity	Chien	Felicity	Chien
2006	27.6	27.8	24.9	25.0
2007	27.4	27.6	20.9	20.7
2008	28.2	28.6	16.0	16.0
2009	28.3	28.6	21.3	21.1
2010	29.2	29.5	18.6	17.8
2011	27.2	27.5	25.0	24.9
2012	29.0	29.0	20.0	19.2
2013	25.2	25.3	15.0	13.6
Mean	28.1	28.4	21.0	20.7

Mortality

No recent mortalities of sack oysters were observed in 2013 square meter samples in the Terrebonne Basin (Table 5.8). Sister Lake and Bay Junop were the only areas that showed recent mortality of seed oysters, with 1 individual discovered in each area among all samples.

Table 5.8 Overall percent mortalities of spat, seed and sack oysters in 2013 for all areas within Coastal Study Area (CSA) 5.

Region	Area	Spat	Seed	Sack
Western TB	Sister Lake	6.6	0.7	0
	Bay Junop	13	4.0	0
	Lake Mechant	0	0	0
Eastern TB	Lake Felicity	0	0	0
	Lake Chien	1.2	0	0

Fouling Organisms / Predators / Disease

Five incidental species (hooked mussels, mud crab, oyster drill, stone crab, and blue crab) were collected in square meter samples (Table 5.9). Hooked mussels were the incidental species with most abundance and were more prevalent in the western TB samples, having an overall average of 10.9/sample. Of this overall average, Sister Lake had the highest occurrence with 12.0/sample; Eastern TB samples showed an average of 0.07/sample. The only other common species was the mud crab.

Table 5.9 Average numbers of hooked mussels, oyster drills, and select crab species per sample by seed ground or reservation and overall (TB=Terrebonne Basin).

		Numbers Per Sample				
Region	Seed Ground	Hooked Mussels	Mud Crab	Oyster Drill	Stone Crab	Blue Crab
Western TB	Sister Lake	12.0	0.5	0.02	0.12	0
	Bay Junop	6.75	1.9	0	0	0.05
	Lake Mechant	5.8	0.6	0	0	0
	Overall	10.2	0.88	0.01	0.08	0.01
Eastern TB	Lake Felicity	0	0	0	0	0
	Lake Chien	0.1	0.7	0.5	0	0
	Overall	0.07	0.5	0.3	0	0

Dermo (*Perkinsus marinus*) may cause extensive oyster mortalities in conditions of high salinities and water temperatures. Oysters from the Terrebonne Basin public oyster areas were analyzed for the presence of Dermo by the University of New Orleans, and will be presented in a separate section.

Sedimentation/Reef Burial
Sediment overburden was noted at 6 of the 10 sample sites visited in Sister Lake this year. Depth of burial estimates ranged from 1 – 5” of mud. No reef burial was noted at samples collected in Bay Junop, or Lakes Mechant, Felicity, and Chien.

Deepwater Horizon Oil Spill and Related Response Actions
The BP Deepwater Horizon oil spill released millions of barrels of oil into the Gulf of Mexico affecting the Louisiana coastline, including oyster resources. The impacts of oil on oyster resources continue to be of concern. Assessment continues on the direct and indirect impacts of oil and response actions to Louisiana’s near shore environment, including to oysters and oyster habitat.

Tropical Weather / Flooding Events
Hurricane Isaac made land fall near Fourchon, LA and crossed the Terrebonne basin during the last week of August 2012. Storm surge of up to 5 ft above normal tide levels were experienced in parts of the basin. The September 2012 dredge samples showed an increase in overall oyster mortality from the previous month’s samples; however, whether this can be attributed to Hurricane Isaac is uncertain.

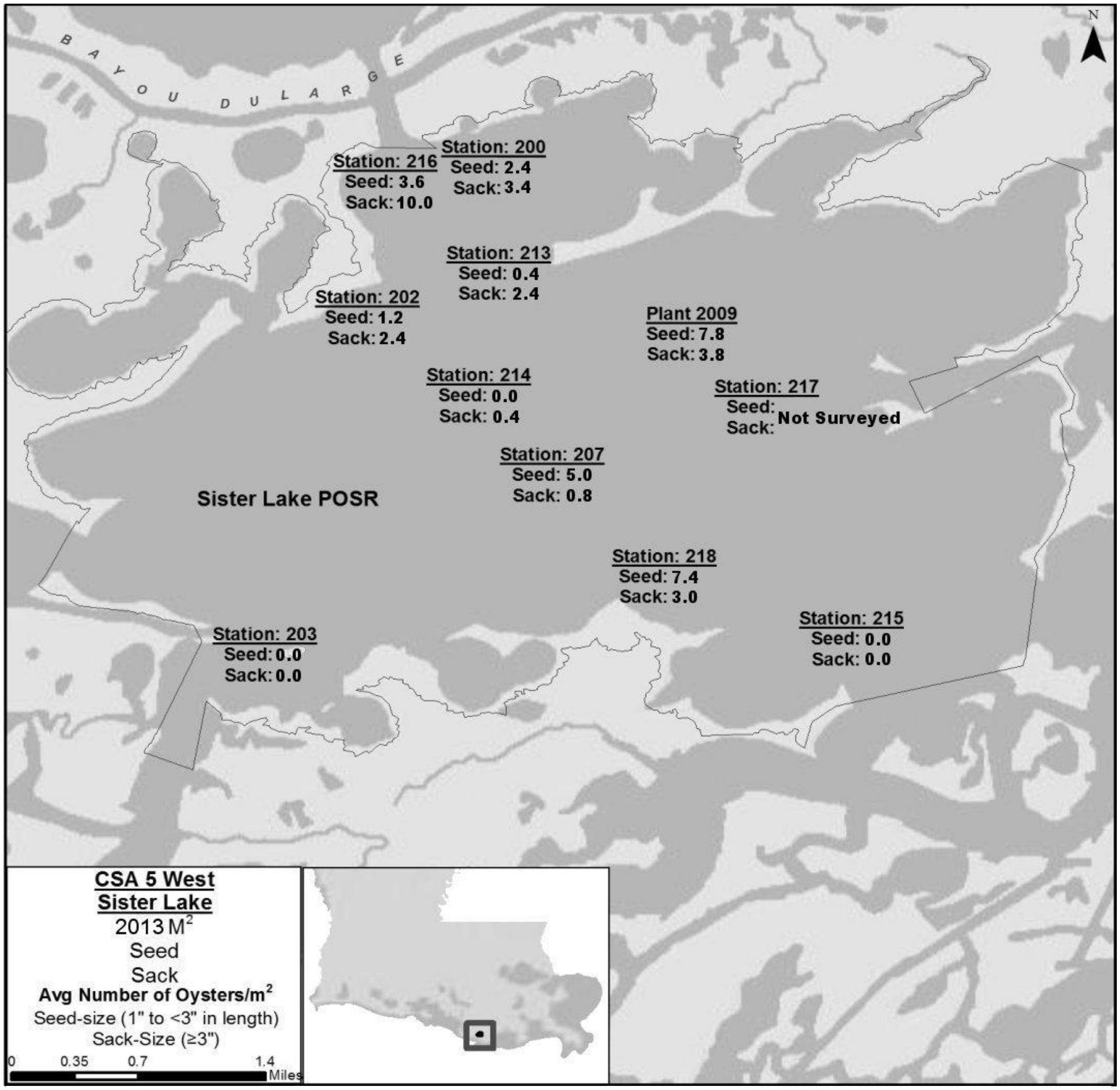


Figure 5.3 Results from each square-meter sampling station within Sister Lake.

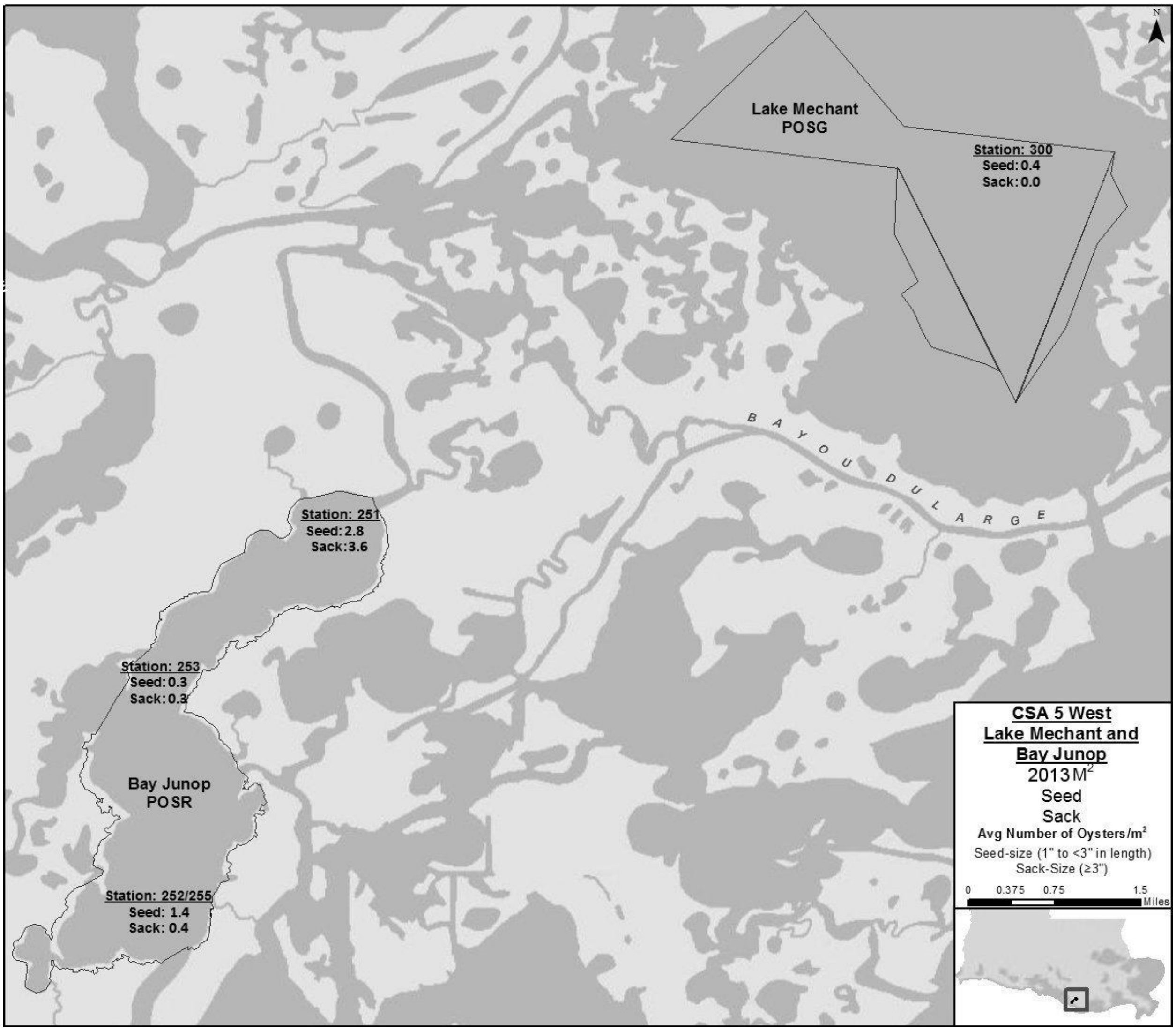


Figure 5.4 Results from square-meter sampling stations within Bay Junop and Lake Mechant.

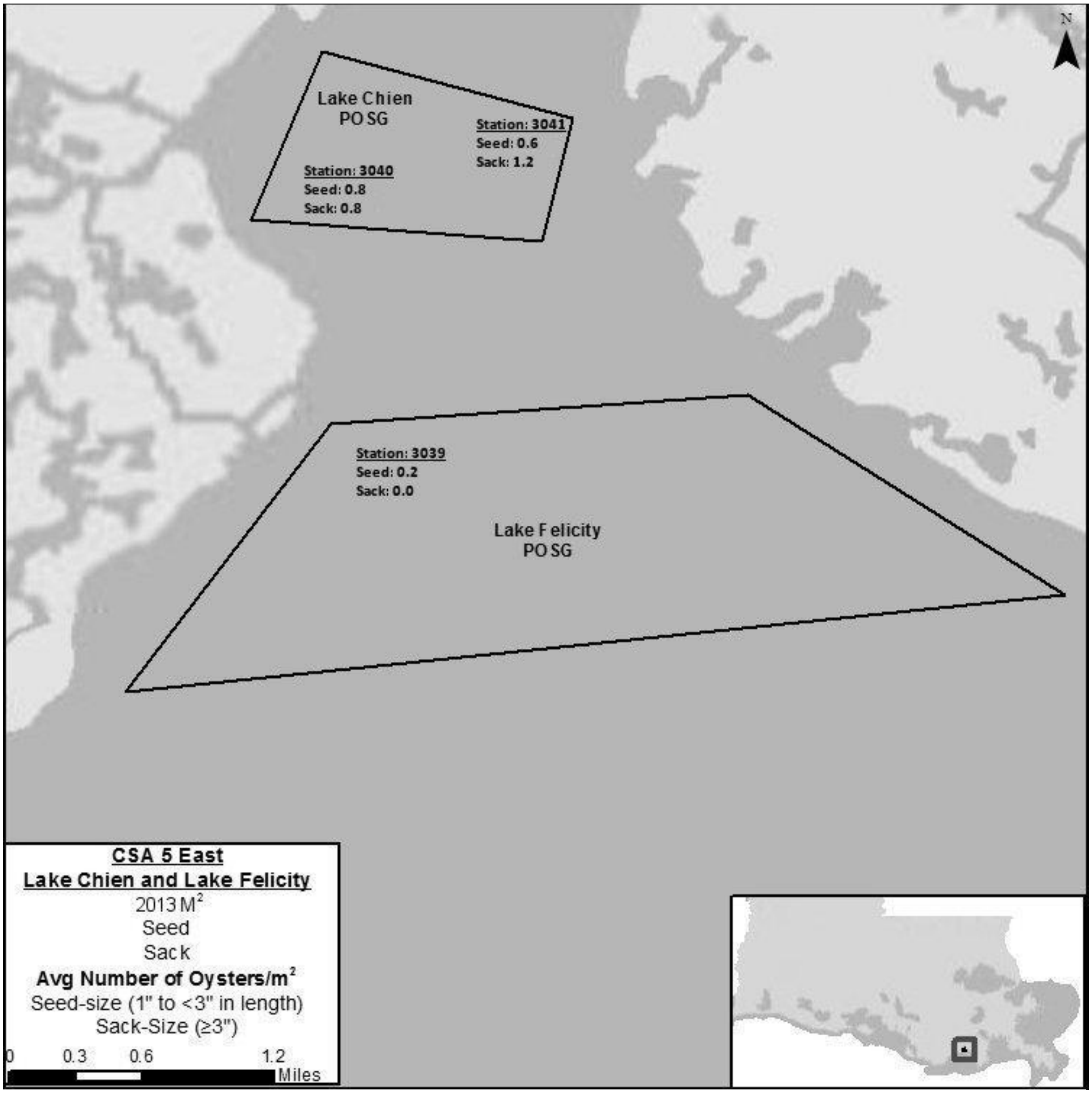


Figure 5.5 Results from square-meter sampling stations within Lake Chien and Lake Felicity.

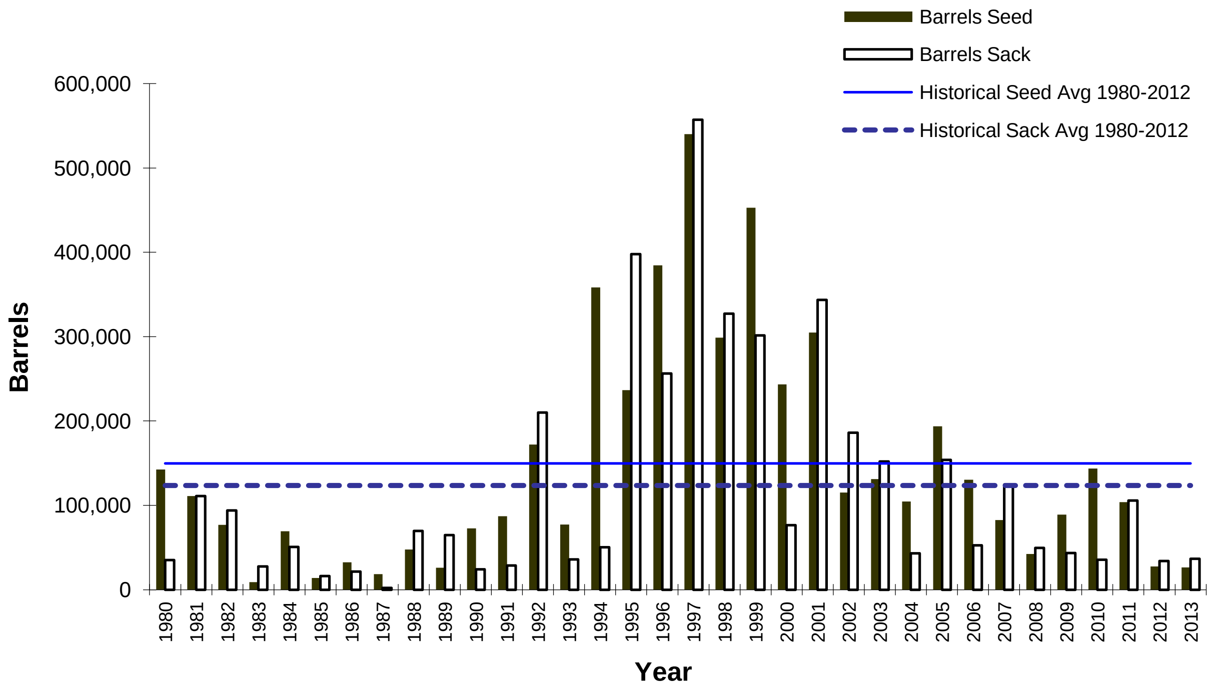


Figure 5.6 Sister Lake historic oyster stock availability. 2012 data recalculated based on 2013 reef acreage adjustment.

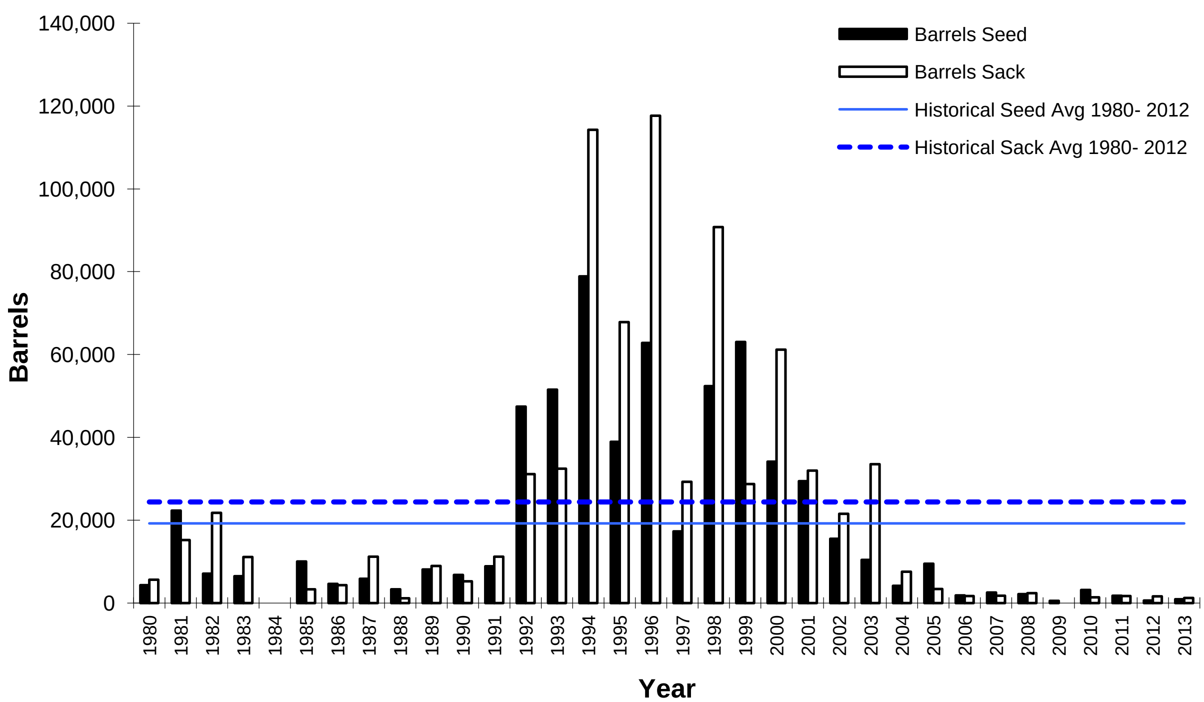


Figure 5.7 Bay Junop historic oyster stock availability.

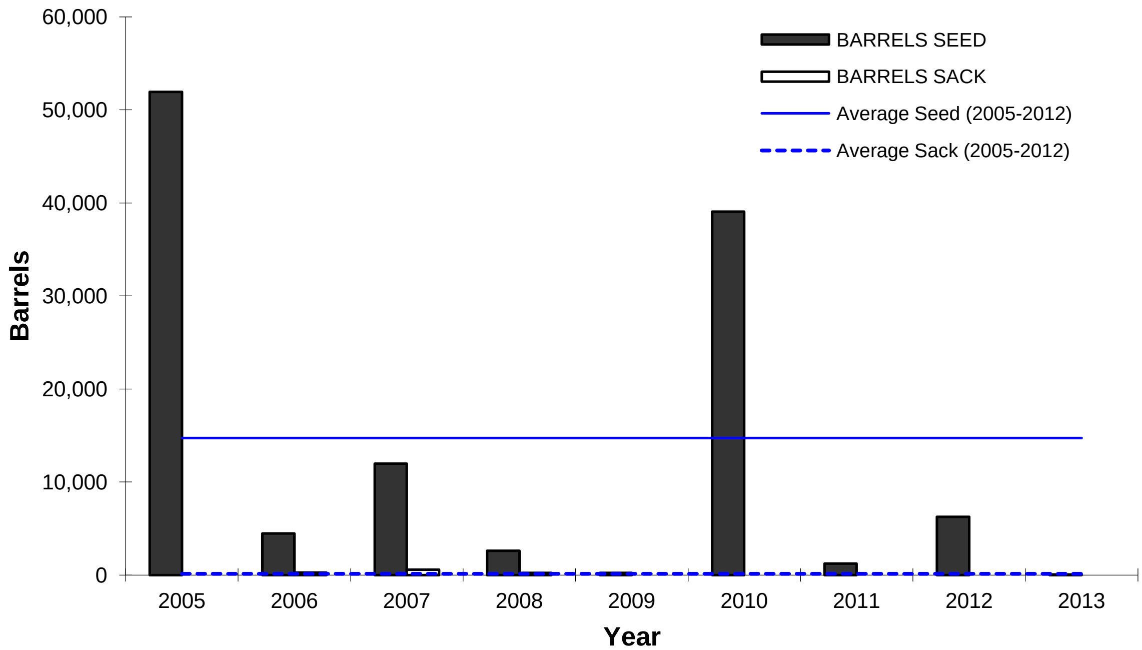


Figure 5.8 Lake Mechant historic oyster stock availability.

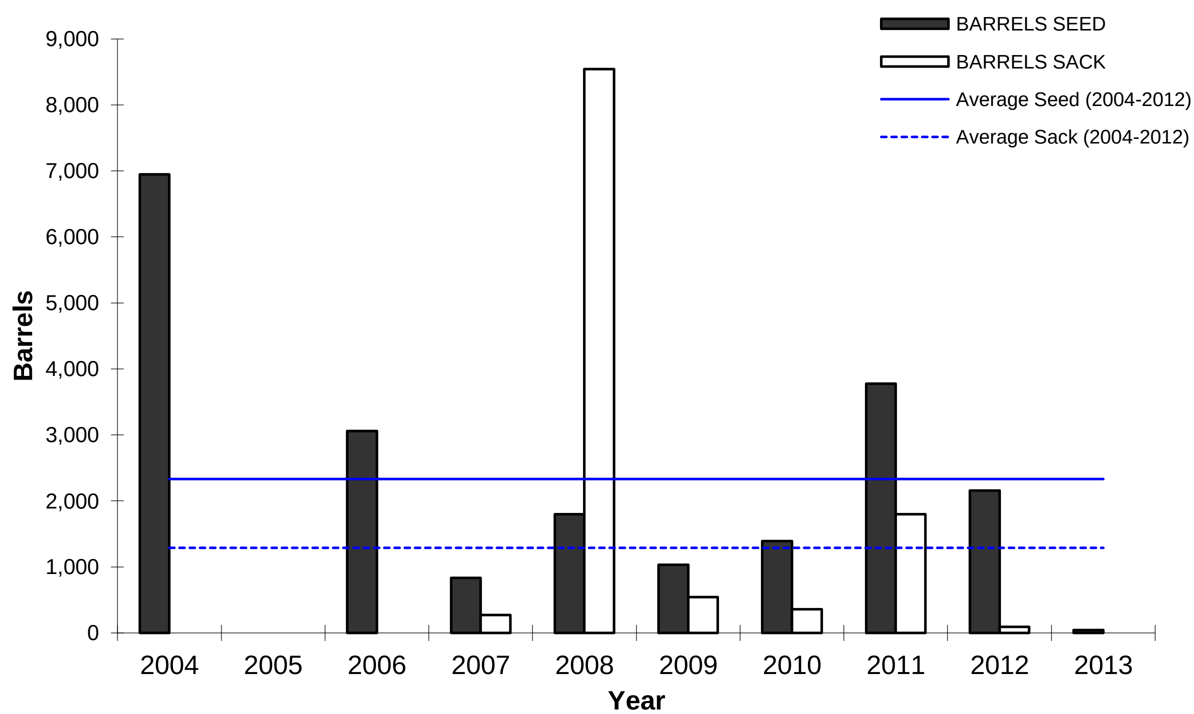


Figure 5.9 Lake Felicity historic oyster stock availability.

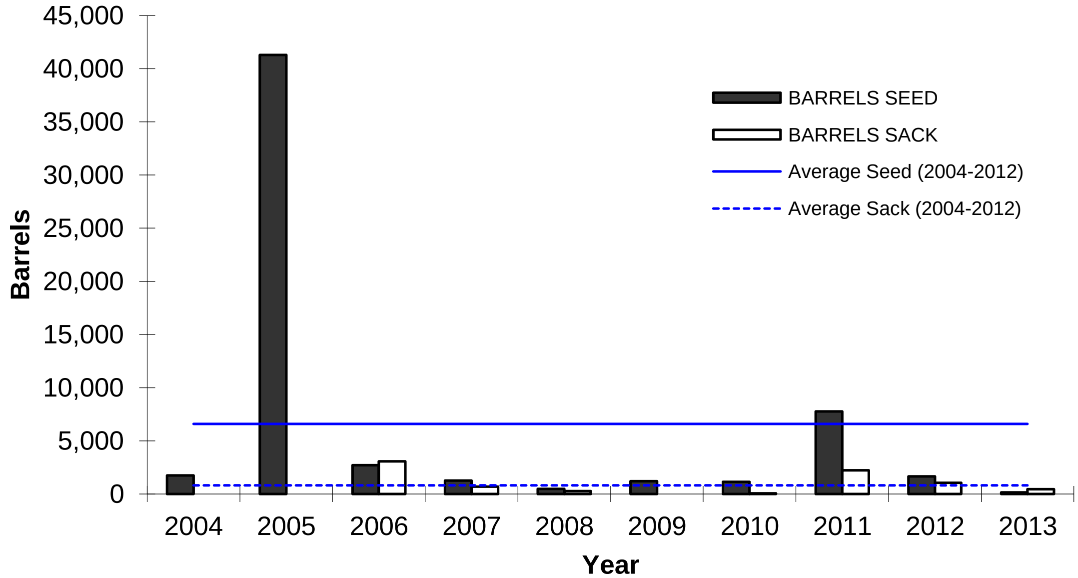


Figure 5.10 Lake Chien historic oyster availability.

<u>2012/2013 Oyster Season Summary</u>

Oyster harvests on the POSGs and POSRs were monitored through boarding reports and trip ticket records. These data were used to calculate annual estimates for each public oyster area (Tables 5.10 and 5.11).

Sister Lake: The Sister Lake POSR was closed for the 2012 – 2013 season, and no harvest was documented via LDWF boarding runs.

Lake Mechant: Lake Mechant opened on October 29, 2012, and was open for three days before the Department of Health and Hospitals (DHH) implemented a seasonal public health closure on November 1, 2012. Total fishing effort was 69 vessel-days, of which 61 vessel-days were for the harvest of market oysters. Total estimated harvest was 2,243 sacks of market oysters and 1,075 barrels of seed oysters. No harvest activity was observed on the cultch plant located within the POSG.

Bay Junop: Bay Junop was opened on October 29 by the LDWF. The DHH implemented a seasonal public health closure on November 1, 2012, which excluded the majority of the POSR to oyster harvest, after which fishing effort was very low. Twenty-six vessel-days of fishing effort produced an estimated 1,163 sacks of market oysters.

Lake Chien / Lake Felicity: Lake Chien and Lake Felicity were open from October 29 to November 3, 2012. Thirty-seven vessel-days of effort yielding 1,022 sacks of market oysters were estimated to have been harvested from Lake Chien; of this total, 20 vessel-days of effort and 604 sacks of market oysters were documented from the 2004 cultch plant. Harvest activity in Lake Felicity included 1 vessel-day of effort producing an estimated 37 sacks of market oysters and no seed oysters.

Compared to historic means, 2012 harvests of market oysters on open public grounds varied greatly. Harvest of market oysters in Lake Felicity and Bay Junop were 96% and 83% below long-term means, respectively, while the harvest of market oysters in Lake Chien and Lake Mechant were above long-term means.

Lake Mechant was the only area in the Terrebonne Basin where seed sized oysters were harvested during the 2012 season, and the catch was 78% below the long term average. However, Lake Mechant has only been designated a POSG since 2003, and has only been open to harvest five times since its inception. Fourteen samples were collected from six bedding vessels during the 3-day season to determine the percent cultch in seed stock harvested. Percentages of cultch taken ranged from 18 – 46% with an overall average cultch take of 28% per bedding load.

Table 5.10 Annual totals and long-term means (excluding 2012) of commercial seed oyster (barrels) and sack oyster (sacks) harvests from Sister Lake, Lake Mechant, and Bay Junop (NS=no season; X=not designated as seed ground or reservation).

YEAR	SISTER LAKE		BAY JUNOP		LAKE MECHANT	
	Seed	Sack	Seed	Sack	Seed	Sack
1995	51,160	48,824	NS	NS	X	X
1996	20,055	40,019	3,770	26,908	X	X
1997	31,668	43,727	NS	NS	X	X
1998	15,228	16,510	6,205	20,345	X	X
1999	29,934	47,586	NS	NS	X	X
2000	NS	NS	NS	NS	X	X
2001	18,183	34,060	NS	NS	X	X
2002	NS	NS	40	1,031	X	X
2003	11,840	92,580	NS	NS	X	X
2004	NS	NS	5	2,623	0	2,211
2005	3,200	81,788	NS	NS	NS	NS
2006	NS	NS	10	3,890	NS	NS
2007	16,960	42,514	NS	NS	19,665	13,703
2008	600	5,530	0	737	NS	NS
2009	4,610	13,676	NS	NS	NS	NS
2010	NS	NS	0	433	0	91
2011	15,765	86,812	0	100	0	0
2012	NS	NS	0	1,163	1,075	2,243
MEAN	18,267	46,136	1,254	7,008	4,916	767

Table 5.11 Annual totals and long term means (excluding 2012) of seed oyster (barrels) and sack oyster (sacks) harvests from Lake Felicity and Lake Chien cultch plants (NS=no season; X=not designated as seed ground or reservation).

YEAR	LAKE FELICITY		LAKE CHIEN TOTAL	
	Seed	Sack	Seed	Sack
2005	15	0	253	0
2006	0	0	1,940	0
2007	470	4,830	2,157	2,439
2008	0	0	205	17
2009	NS	NS	NS	NS
2010	0	205	0	405
2011	671	351	156	2,458
2012	0	37	0	1022
MEAN	193	898	785	887

Coastal Study Area (CSA) 6 – 2013 Oyster Stock Assessment

Introduction

Oyster reefs found in the Vermilion/East and West Cote Blanche/Atchafalaya Public Oyster Seed Ground generally fall within the boundaries of Coastal Study Area 6 (CSA6). The inside oyster seed ground, promulgated by the Louisiana Wildlife and Fisheries Commission in 1990, consists of that portion of state water bottoms found generally north of a line from the western shore of Vermilion Bay and Southwest Pass eastward to Point Au Fer. The outside area, designated in 1988, consists of Louisiana State Territorial Waters from the private oyster lease boundary near Mound Point/Marsh Island eastward to Point Au Fer. Since 1986 (prior to the official designation of these areas as seed grounds), LDWF managed the oyster resources found on local state water bottoms in a manner similar to present seed ground management procedures. This allowed limited harvest/relays from the Vermilion Bay area reefs when oyster abundance and distribution permitted.

The Vermilion/Cote Blanche/Atchafalaya Bays Complex is a large, primarily open-water brackish system with the public oyster seed grounds consisting of approximately 541,787 water bottom acres. Primary influences on the bays' dynamic salinity regime are the Gulf of Mexico, Atchafalaya River and the adjacent Wax Lake Outlet, and the Vermilion River. In general, the public oyster seed grounds within CSA 6 are highly influenced by freshwater discharge from the Atchafalaya River. Typically, oyster reproduction occurs in the fall after the river stage abates, with oysters growing to seed size (1 inch to < 3 inches) by the following spring. However, spring and early summer floodwaters depress salinities, placing extreme physiological stress on the organisms. These low salinities, coupled with high water temperatures through the summer months, typically results in extensive oyster mortalities on the public grounds. Occasionally, however, reduced freshwater inflow from the Atchafalaya River leads to higher-than-normal salinities and the normal annual cycle of extensive oyster mortalities is broken, leading to a harvestable population of seed oysters during the following oyster season (September through April). Such was the case in 2000, 2001, 2005, 2006, and 2007 when sizeable quantities of seed oysters were available for harvest.

An overall Vermilion Bay area stock assessment of estimate oyster abundance is not possible at this time, as figures relative to oyster reef sizes are not available. However, data collected from this year's sampling program will be compared to previous years' data (comparisons of catch-per-unit-effort). Additionally, hydrologic conditions, marine fouling, and oyster predators on sampled reefs are examined. The effects of extended high Atchafalaya River levels during the period of January 2013 through July 2013 are addressed. In addition, information regarding the 2012/2013 oyster season harvest on the Vermilion Bay area public oyster seed grounds are presented.

Methods

Field sampling was conducted on July 10, 2013. A total of ten stations (Figures 6.1 and 6.2) were sampled with five replicate quadrat samples collected at each station, characterizing the spatial distribution of sampling effort on the hard-bottom areas found within the system. Upon reaching the designated site, the square meter frame was randomly thrown onto the oyster reef. A SCUBA diver removed all oysters, associated macroscopic organisms, and loose surface shell within the frame. All live oysters, and shells from recently dead oysters, were counted, measured in five millimeter (mm) intervals, then classified as spat (<25 mm), seed (25 mm to < 75mm), or sack oysters (≥75mm). Shells from recently dead oysters were defined as "box" (both valves attached) or "valve" (one valve). Oyster size was determined by measuring the "straight-line" distance from the hinge to the apex of the shell. Live predators and fouling organisms were counted. Cultch type and reef condition were noted. Water temperature and salinity data were collected in conjunction with square meter oyster samples.

<u>Results and Discussion</u>

Seed and Sack Stock

Live seed oysters were found at only three of the ten sample sites, with average density numbers of 0.4, 1.2, and 1.4 per replicate at Dry Reef/Vermilion Bay, Lighthouse Point, and Indian Point respectively. All live seed-sized oysters were found at sample sites in the vicinity of Southwest Pass in the western portion of the study area. No live sack-sized oysters were found during the survey (Figures 6.1 and 6.2).

Low production years associated with extended periods of high Atchafalaya River output are not uncommon on the seed grounds of this bay system. Near 100% oyster mortality on the grounds was noted in seven of the previous ten years and is reflected by the annual oyster stock assessment data (Figure 6.3).

Spat Production

Despite the presence of suitable substrate at all locations, no live spat were collected during the 2013 square meter sampling effort (Figures 6.1 and 6.2). Low spat productivity during periods of high Atchafalaya River flow (with associated low salinity conditions) is common in this bay system.

Fouling organisms

An overall decrease of more than 64% in hooked mussel (*Ischadium recurvum*) occurrence on the seed ground compared to last year's assessment was documented, with an increase in numbers noted only at the Dry Reef/Vermilion Bay site (Table 6.1).

Oyster Predators

No evidence of the southern oyster drill (*Stramonita haemastoma*) was noted during sampling, which is not surprising considering the depressed salinities normally found in this area. These predatory marine snails are more often associated with high salinity waters where they are known to prey heavily on oysters and other bivalve species. A significant overall decrease (79%) in mud crab (*Xanthidae spp.*) occurrence on sampled reefs was observed when compared to the 2012 assessment. Only the Lighthouse Point site saw a slight increase in mud crab numbers. No blue crabs (*Callinectes sapidus*) were collected. Stone crabs (*Menippe adinia*) at the rate of 0.4 and 0.6 per replicate were captured at the Lighthouse Point and North Reef stations respectively (none were found at the other eight sites).

Dermo

Dermo (*Perkinsus marinus*), a protozoan parasite prevalent in oysters, may cause extensive mortalities in conditions of high salinities and water temperatures. As in previous years, an attempt to collect samples from the eastern and western part of the system for analysis of the presence of this pathogen was made. An oyster dredge was used to collect a sufficient number of seed and sack-sized oysters from the Indian Point (west) and Middle Reef (east) sites. All samples were forwarded to Dr. Tom Soniat (University of New Orleans) for quantification of the infestation rate of the protozoan. Results of Dermo analysis are contained within a separate section of this document.

Mortality

The oyster resource found in the area is highly vulnerable to low salinity/high turbidity conditions often seen as a result of extended freshwater conditions associated with high Atchafalaya River discharge. Independent of local rainfall, rising water levels at the Butte La Rose gauge can generally be tied to falling salinity levels in the Vermilion Bays complex. This correlation was documented for the late winter and spring of 2012/2013 (Figure 6.4), with its effects on local oysters noted in this year's assessment.

Following the July 2012 summer stock assessment, August dredge samples found promising numbers of spat, seed, and sack-sized oysters available at the western sites in the vicinity of Southwest Pass. Eastern samples showed potential with successful spat set at most locations. Continued sampling through the fall and early winter found growth, with increasing numbers of seed and sack oysters noted through the end of 2012. Despite the increase in Atchafalaya River discharge and associated falling salinity levels at the beginning of 2013, no mortality was documented during the late winter and early spring. By May 2013 high river levels (above 15 feet at Butte La Rose) had salinity hovering around 2 ppt or less throughout the system, but water temperatures were low enough to keep stress levels depressed. In June however, water temperature rose to as high as 30°C and the low salinity condition began to impact the oyster resource. Significant mortality was documented in the early June dredge samples with an associated decrease in the numbers of available live oysters. Despite a rise in salinity levels due to persistent south and southwest winds toward the end of the month, continued mortality was noted in the late June dredge samples. Square meter sampling for the July 2013 assessment found few live oysters remaining (Figures 6.1 and 6.2)

Tropical and Climatic Events

No tropical storms or significant climatic events affected the Vermilion area seed grounds since the 2012 assessment.

<u>2012/2013 Oyster Season Summary</u>

Methods

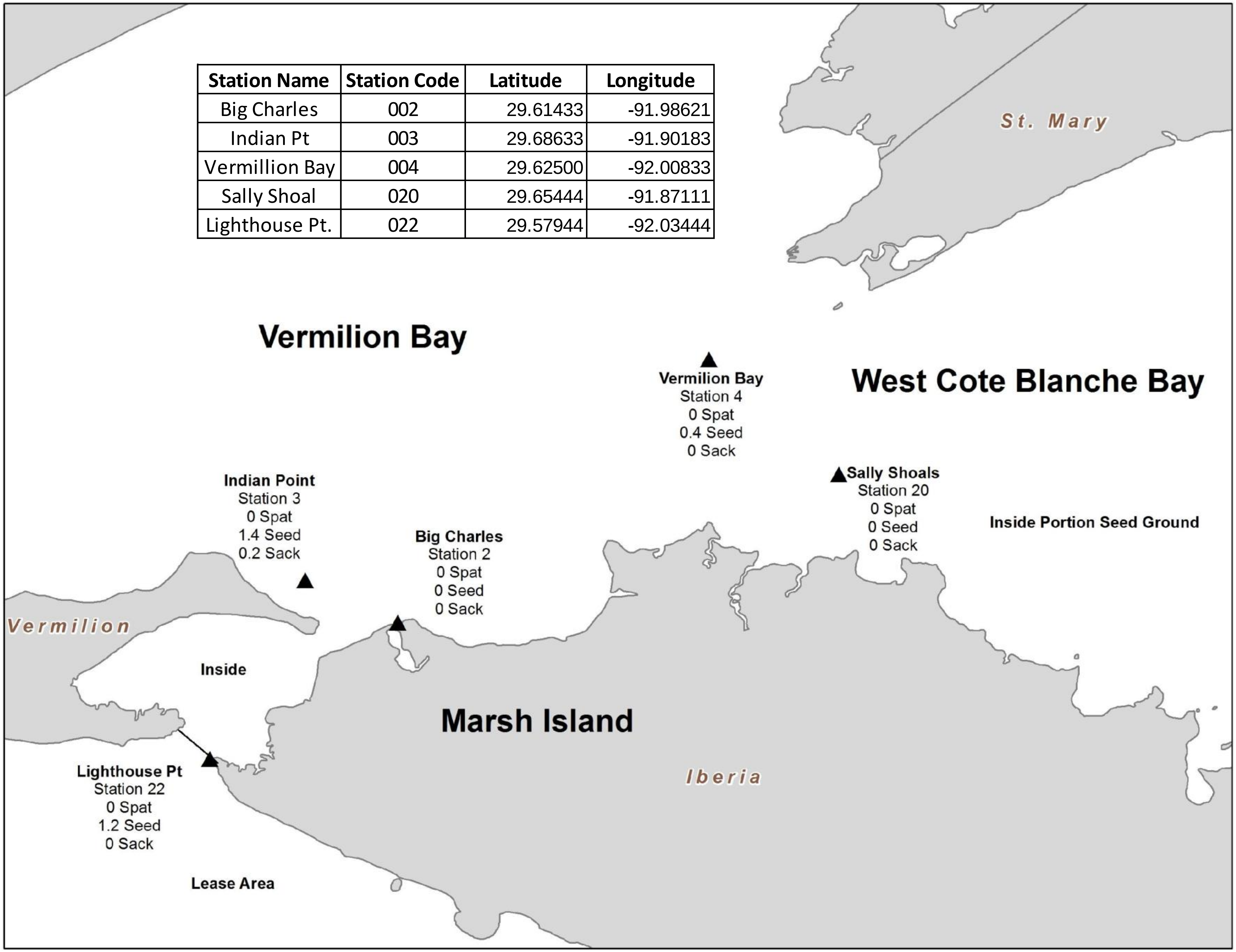
Roving surveys on portions of the seed grounds with "OPEN" designation under DHH's classification system and areas under DHH relay permit are made to obtain fishery dependent data (i.e. harvest estimates). Fishermen working the seed ground are surveyed and asked to provide estimates of past and current catch rates as well as an estimate of future fishing effort.

These data are summarized weekly to maintain a cumulative estimate of harvest for specific reef complexes. Trip ticket data is analyzed to provide additional harvest information.

Results & Discussion

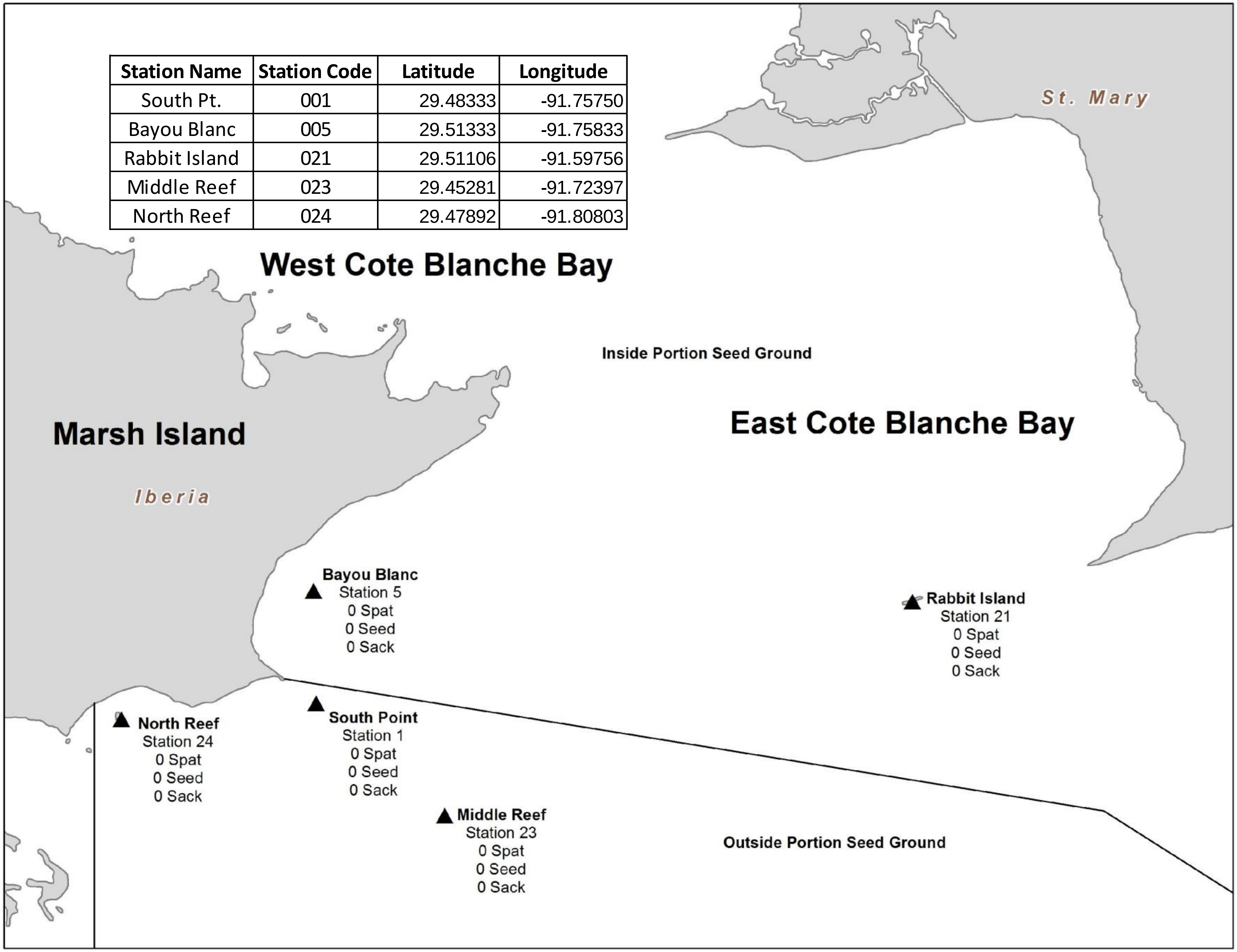
The Vermilion/East and West Cote Blanche/Atchafalaya Bay Public Oyster Seed Grounds opened one-half hour before sunrise on September 5, 2012 and remained open until one-half hour after sunset on April 30, 2013.

An estimated 7,226 sacks of market-size oysters were taken from the public oyster seed ground, with the entirety harvested from reefs in the vicinity of Southwest Pass/ Vermilion Bay. An estimated 375 barrels of seed-sized oysters were taken from the same area.



Station Name	Station Code	Latitude	Longitude
Big Charles	002	29.61433	-91.98621
Indian Pt	003	29.68633	-91.90183
Vermillion Bay	004	29.62500	-92.00833
Sally Shoal	020	29.65444	-91.87111
Lighthouse Pt.	022	29.57944	-92.03444

Figure 6.1 Map designating CSA6 2013 oyster square meter sample stations in the western part of the Vermilion, East and West Cote Blanche and Atchafalaya Bays public oyster seed ground. Data displayed below station numbers represent average spat, seed and sack oysters per square meter sample.



Station Name	Station Code	Latitude	Longitude
South Pt.	001	29.48333	-91.75750
Bayou Blanc	005	29.51333	-91.75833
Rabbit Island	021	29.51106	-91.59756
Middle Reef	023	29.45281	-91.72397
North Reef	024	29.47892	-91.80803

Figure 6.2 Map designating CSA6 2013 oyster square meter sample stations in the eastern part of the Vermilion, East and West Cote Blanche and Atchafalaya Bays public oyster seed ground. Data displayed below station numbers represent average spat, seed and sack oysters per square meter sample.

Year	mean density seed/sample	mean density sack/sample	Seed/sack ratio
1999	5.5	0.2	27.5:1
2000	81.4	3.3	24.7:1
2001	28.8	4.8	6.0:1
2002	2.25	0.25	9.0:1
2003	1.2	0	No Sack Oysters
2004	4.3	0	No Sack Oysters
2005	14.8	0	No Sack Oysters
2006	16.1	0.5	32.2:1
2007	11.6	0.8	14.5:1
2008	1.3	0	No Sack Oysters
2009	3.4	0	No Sack Oysters
2010	0.8	0.12	6.7:1
2011	0.32	0.02	16.0:1
2012	1.78	0.04	44.5:1
2013	0.3	0.02	15.0:1

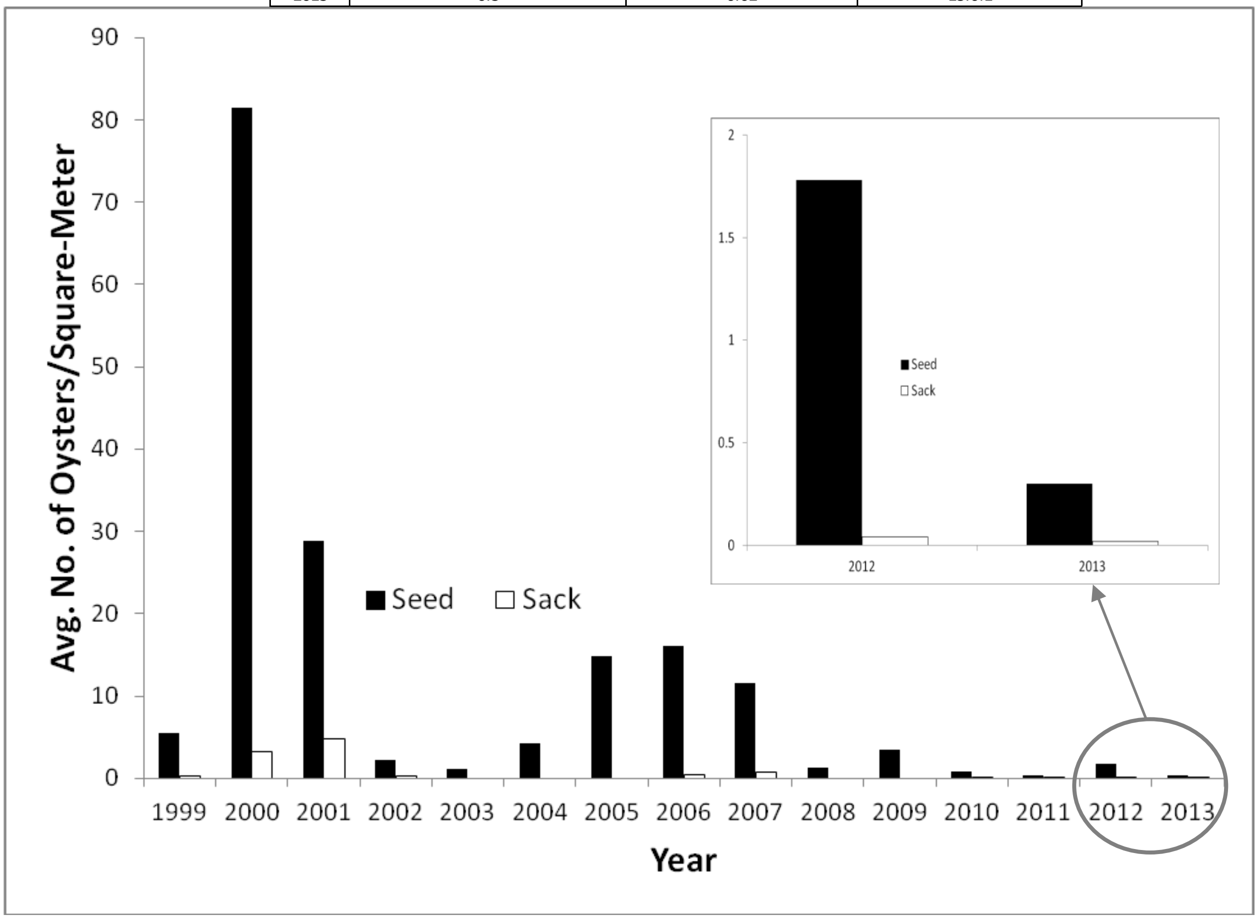


Figure 6.3. Graph depicting mean density of live seed and sack size oysters collected in CSA6 square meter samples (by year). Data table included.

Table 6.1. Mean density of the hooked mussel, *Ishadium recurvum*, recorded at each CSA6 square meter station (by year).
** 2011 was the first year for square meter samples for these stations*

Station no.	Station name	2006	2007	2008	2009	2010	2011	2012	2013
001	South Pt./Marsh Island	16.0	26.0	1.0	0.0	11.2	1.4	46.4	0.0
002	Big Charles	17.0	16.0	2.5	0.0	18.4	5.2	21.2	4.8
003	Indian Point	9.0	33.5	0.5	16.0	18.2	20.4	16.6	5.4
004	Dry Reef/Vermilion Bay	0.0	0.0	2.0	37.0	0.0	6.6	29.8	38.2
005	Bayou Blanc	7.0	18.5	2.5	0.0	4.0	2.0	13.4	9.0
020*	Sally Shoals	*	*	*	*	*	3.8	25.2	4.8
021*	Rabbit Island	*	*	*	*	*	0.0	0.0	0.0
022*	Lighthouse Point	*	*	*	*	*	11.8	5.2	0.8
023*	Middle Reef	*	*	*	*	*	0.2	11.8	0.8
024*	North Reef	*	*	*	*	*	4.4	12.6	4.6

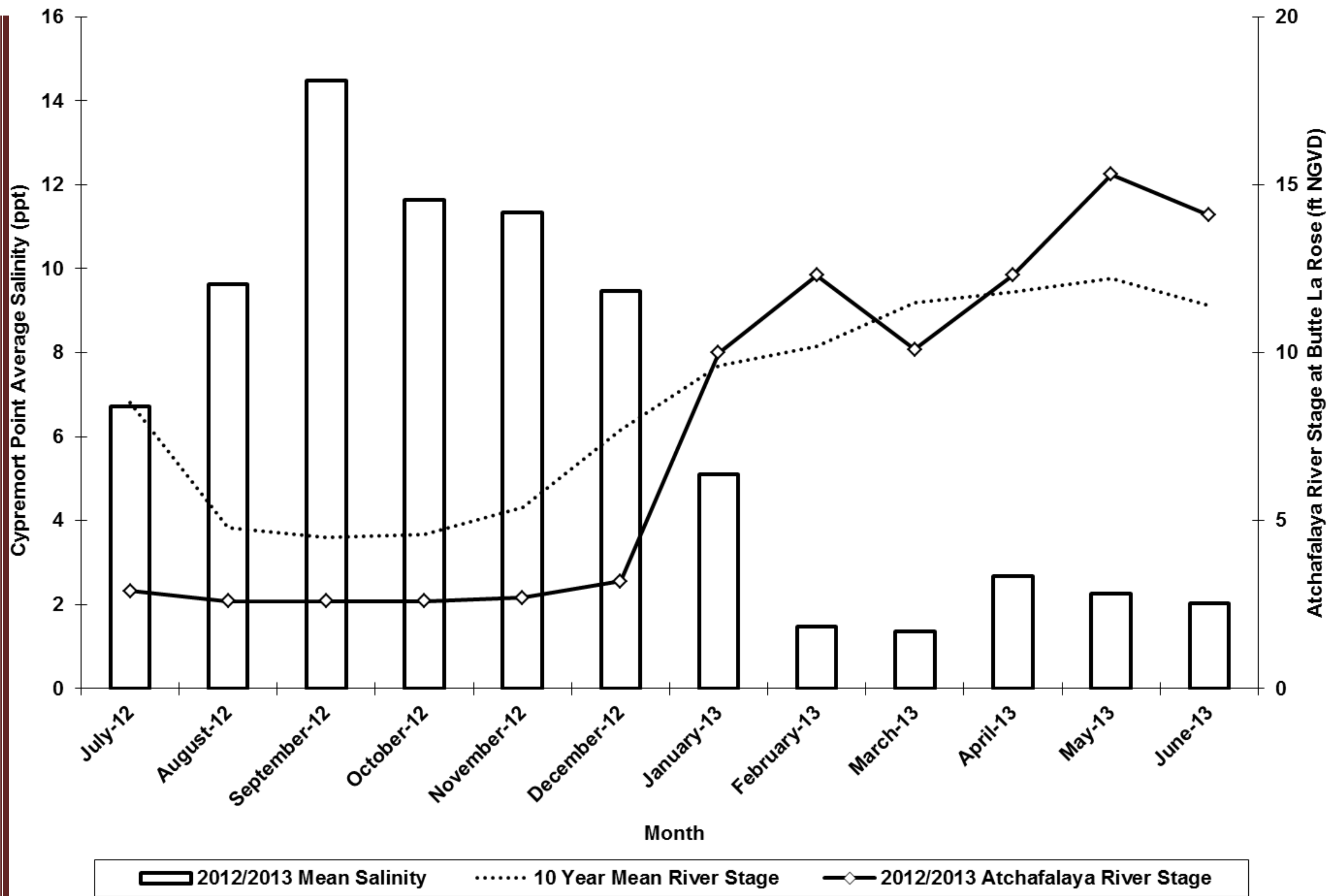


Figure 6.4. Graph depicting Atchafalaya River levels at Butte La Rose gauge and average salinity for Cypremort Point, LA during the period July 1, 2012 through June 30, 2013 Ten year average monthly river stage at Butte La Rose is included.

Coast Study Area (CSA) 7 – 2013 Oyster Stock Assessment

Introduction

Louisiana Department of Wildlife and Fisheries' (LDWF) Coastal Study Area VII is located in Southwest Louisiana, from the Louisiana/Texas state line to Freshwater Bayou in Vermilion Parish. It is comprised of Calcasieu and Mermentau River basins and the eastern portion of the Sabine River Basin. Calcasieu Lake is located at the southern end of the Calcasieu River basin in Calcasieu and Cameron parishes. It consists of approximately 58,260 water bottom acres with oyster reefs located throughout the lake, especially in the southern end. The Mermentau River basin has no oyster harvesting areas. Sabine Lake is located at the southern end of the Sabine River basin in Cameron parish. It consists of approximately 55,057 water bottom acres with approximately 34,067 acres in the Louisiana portion and the remainder in the Texas portion. Oyster reefs are located mainly in the very southern portion of the lake.

Oyster seasons in Calcasieu Lake occurred prior to 1967, but were closed from 1967 through 1974. Oyster harvesting resumed in 1975 with only taking by hand or tongs allowed. In 2004, legislation (Act 479) was passed allowing for the use of hand oyster dredges of three feet wide or less in Calcasieu Lake. In 2006, legislation (Act 398) was passed allowing the use of mechanical retrieval systems for the dredges. In 2011, legislation (Act 329) was passed restricting oyster harvest in Calcasieu Lake to those with a Calcasieu Lake Oyster Harvest Permit. This permit was restricted to 126 oyster harvesters, of which 63 had to have historical oyster landings from Calcasieu Lake. In 2012, legislation (Act 541) removed the landings requirement as well as the restriction on the number of harvesters that could possess the permit.

Oyster seasons in Sabine Lake haven't occurred since the early 1960's based on anecdotal information; neither Texas nor Louisiana can document harvest after that time and no concrete harvest data has been located.

For assessment purposes, Calcasieu Lake has always been divided into two areas – Eastside and Westcove (the Calcasieu Ship Channel being the dividing line). In 1992, Louisiana Department of Health and Hospitals (LDHH) also divided the lake into two separately managed areas – Calcasieu Lake Conditional Managed Area (CLCMA) and West Cove Conditional Managed Area (WCCMA). When this change occurred the two areas were also managed for health related closures based on river stage of the Calcasieu River at Kinder, LA. CLCMA would close when the river stage reached to 12 feet and the WCCMA would close when the river stage reached 7 feet. Once the river fell below these levels for 48 hours the LDHH would reopen the areas for harvest. LDHH changed the CLCMA river stage threshold in 1998 to 13.5 feet. In 2004 LDHH changed CLCMA to Growing Area (GA) 29 and WCCMA to GA30 (Figure 7.1).

Calcasieu Lake recent historical season dates, DHH closures, season extensions, with notes on closures, law and management criteria changes can be seen in Table 7.6.

LDHH also limited the amount of acreage available to oyster harvest on the Eastside due to water quality standards. Oysters can only be harvested in the southern portion of the area (GA29) where water quality meets minimum standards. The total area has been changed several times over the years with the current acreage being approximately 26,736 water bottom acres. GA30 has remained the same at approximately 9,248 acres of water bottom. The Louisiana portion of Sabine Lake (GA 31) has approximately 34,067 water bottom acres (Figure 7.3). This area was cleared by LDHH in March of 2011 for harvesting, but LDWF has not opened a season on this area at this time. Since it is cleared for harvesting by LDHH, LDWF has added the area to be assessed for oyster stocks.

Historical reef acreage for all of Calcasieu Lake is 1,690.95. West Cove consists of 726.98 acres and the Eastside consists of 963.97 acres of oyster reef habitat. The historical reef acreage on the Eastside is made up of reefs that fall both within and outside of the conditional managed area. Therefore, assessments of oyster stock sizes are based on total reef acreage within the lake and not just that portion of reef acreage that lies within areas accessible to commercial fishing.

Beginning in 2011, all LDWF oyster stock assessments in Calcasieu and Sabine Lakes, unless another water bottom assessment is performed, will utilize a combination of acreages determined by side-scan sonar water bottom assessments performed in 2008 and 2011. GA29 has 1,435.8 acres of Reef and 526.5 acres of Exposed Shell. GA30 has 1,119.6 acres of Reef and 2,268.2 acres of Exposed Shell. GA31 has 1,041.0 acres of Reef and 438.5 acres of Exposed Shell (Table 7.1).

Figures 7.2 and 7.4 indicate the Bottom type IIIB areas from 2008 and 2011 assessments for GA29, GA30 and GA31.

LDWF placed a 14.3 acre cultch plant in the southern portion of GA 29 (on the south side of the "Old Revetment") in May of 2009. No oyster harvest was allowed by the LDWF Commission during the 2009-2010 and 2010-11 seasons on this cultch plant.

Methods

The oyster assessment for Calcasieu Lake was derived by taking "meter square" samples. A one meter square frame is randomly tossed in the very near vicinity of the sample station located on a sample location of known Reef or Exposed Shell bottom. There are five replicate samples taken by a SCUBA diver at each station and there are six stations in GA29, four in GA30 and six in GA31 (Figures 7.1 and 7.3). The diver removes all live and dead oysters and shell on the top portion of the reef substrate. Any live and recent dead oysters are measured in five millimeter (mm) groups and divided into three categories – spat (<25mm), seed oysters (25mm – 74mm) and sack oysters (75mm and larger). Oyster predators, and Hooked mussels (*Ishchadium recurvum*) that are collected are identified and tallied. As no bedding (seeding) operations occur in Calcasieu Lake and all harvest is for direct market, the results of data collected are reported in sacks (seed – 360 oyster equals one sack, sack – 180 oysters equals one sack) rather than in barrels, the standard oyster unit of measure utilized in other parts of coastal Louisiana (two sacks = one barrel).

Results and Discussion

Calcasieu Lake (GAs 29 and 30)

Overall oyster availability in the assessed area of Calcasieu Lake is estimated at 59,511 sacks of seed oysters and 169,038 sacks of market oysters. The west cove of Calcasieu Lake (Growing Area 30) accounts for 100% of the estimated stock as no live seed or market-size oysters were collected in samples from the eastern side of the lake (Table 7.1). This remains unchanged from the previous year when no live oysters were collected in samples during the 2012 oyster stock assessment. The estimated oyster stock size represents an approximately 30% decrease in seed and 29% decrease in market oyster abundance compared to 2012 levels, and remains well below the most recent five-year average of oyster availability (Table 7.2).

Sampling on the 2009 cultch plant (Station #3010; Figure 7.1), indicates no present of spat, seed or sack oysters, which is consistent with other sample stations on the east side of Calcasieu Lake. Two consecutive years with no oysters collected in samples in this area is a major concern and may be related to the increase in abundance of Southern oyster drills (*Stramonita haemastoma*) observed on the east side of the lake over the last few years. The one oyster drill collected in square meter samples on the 2009 Cultch Plant calculates to an estimate of 290,521 oyster drills in this area. Decrease in available oysters in the west cove portion of Calcasieu Lake is a big concern. Fishing pressure has increased in this area since the east side of the lake has been closed for the past two seasons. Also, oyster drill abundance appears to be increasing in this area and could lead to future decreases in oyster abundance. The west cove of Calcasieu Lake will need to be monitored very closely; the assessment indicates recent decreases in sack oysters for 2013 as compared to the 2012 stock assessment; this is after a 60.2% drop in 2012 from 2011.

Sabine Lake (GA 31)

Sabine Lake estimated oyster availability in 2013 totaled 395,205 sacks of seed oysters and 1,110,940 sacks of market oysters (Table 7.1). This represents an approximate 29% decrease in seed, but a roughly 25% increase in market oysters compared to 2012 oyster availability (Table 7.2). This lake continues to hold the majority of the oyster resources in Coastal Study Area 7, and may be the combined result of many decades of no harvest, environmental conditions conducive to oyster propagation, and its generally inaccessible location to Louisiana residents.

Hydrology

Average water temperatures for May and June were 23.8^{o}C and 29.7^{o}C respectively. May was cooler and June was warmer than the long term average (LTA) of 1970-2012 (Table 7.5). The average water temperature during the oyster assessment was 29.4^{o}C which is slightly lower that the LTA of 29.6^{o}C.

Average salinities (in parts per thousand - ppt) for May and June were 16.8ppt and 15.6ppt respectively; this is higher than the LTA for the same months (Table 7.5). The average salinity during the oyster assessment was 17.4ppt which is above the LTA of 12.3ppt.

Disease, Fouling Organisms, and Predators

There were no Hooked mussels in the GA29 assessment. GA30 had an average of 43.7 mussels, which is an increase from the 2012 assessments average of 22.7. The 2012 assessment of GA31 showed there to be 1,018.5 mussels per sample station compared to the 639.2 per sample station in 2012. The high numbers in GA31 may be attributed to no oyster dredge activity on the reefs, which tends to break up mussel aggregations due to physical contact with the dredge gear.

There have been very few Southern oyster drills (*Stramonita haemastoma*) present in either the meter square or dredge samples before 2009. Upon review of dredge data since 2005, numbers of oyster drills (a predatory marine snail) began to increase in dredge samples in 2009. With the drought in mid-2010 through 2011, the number increased greatly, with a total collected in 2011 of 421 and 2012 of 171 (Jan. – June), (Figure 7.10). Freshwater influx during February – April 2012 did not seem to alter the numbers of oyster drills. There was only one oyster drill collected during the 2013 oyster stock assessment in GA29. This is lower than the five caught in 2012 and the 20 in 2011. Although the number of oyster drills is lower in the square meter samples, oyster drills continue to be collected during month dredge sampling. With the increase harvest pressure in 2009-2010, then the influx of oyster drills in 2010 to present, the oyster population in GA29 continues to have recruitment issues. There were no oyster drills collected in the square meter samples from GA30 or 31.

There was a total of 83 unidentified mud crabs found in the samples from all three growing areas. No other species of concern were found.

Future Water Bottom Surveys
All the areas open to commercial harvest in GA29, 30 and 31 that likely have oysters have had bottom surveys completed in recent years. The upper half of Calcasieu Lake has not been surveyed, but is not available at this time to oyster harvest because of a continued health-related closure by LDHH. The upper area of Sabine Lake probably has few if any oysters and will not need bottom surveying at this time.

<u>2012-13 Oyster Season</u>
Agreeing with recommendations from LDWF and the Louisiana Oyster Task Force, the Louisiana Wildlife and Fisheries Commission did not open GA29 for the 2012-13 season. GA 30 opened November 1, 2012 and closed April 30, 2013. The sack limit was set at 10 sacks per day for the entire season. GA31 remained closed.

With the low numbers of available oysters in the eastern portion of the state, demand for Calcasieu Lake oysters continues to be high. As mentioned above, the Calcasieu Lake Oyster Harvest Permit is still in place, but did not limit the number of harvesters. The average number of different vessels harvesting oysters per month in the 2012-13 season was 67. The highest month was December 2012 with 94 different vessels harvesting oysters (Figure 7.8).

With GA 29 and 31 closed, all the fishing pressure occurred in GA30. Landings for 2012-2013 from GA 30 were 33,326 sacks (Table 7.3), which represents a sizeable increase over the 29,666 sacks of oysters landed during the previous season. This increase could be related to the increase in numbers of vessels fishing, (an average of 67 different boats per month during the 2012-2013 season versus 58 during the 2011-2012 season), and LDHH health closures closing the season only 39% of the time (Table 7.4).

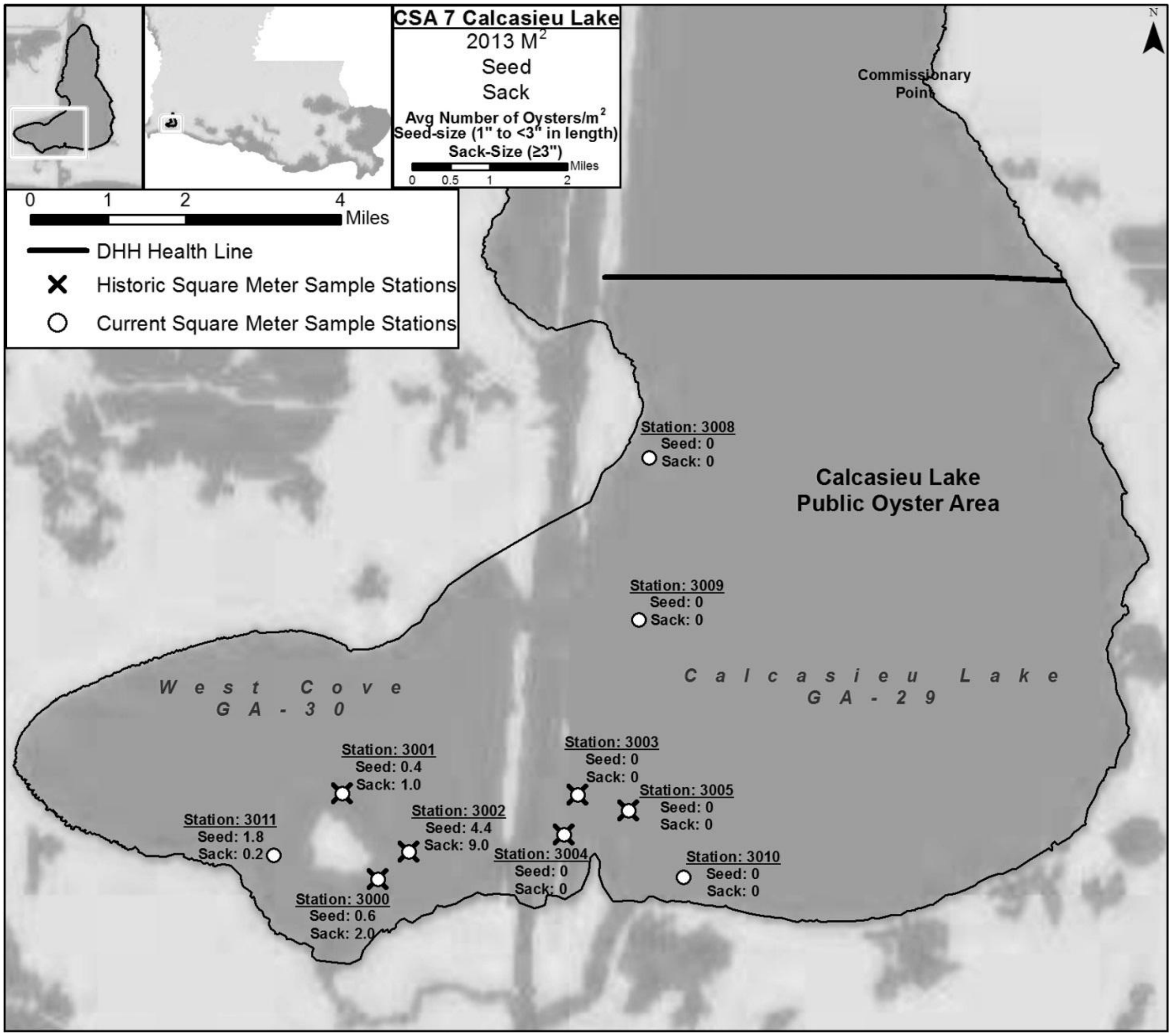


Figure 7.1. The Calcasieu Lake Public Oyster Area indicating the two conditional management area (GA 29 east of the Calcasieu Ship Channel and GA 30 west of the channel), as well as the 2013 oyster square meter sample stations.

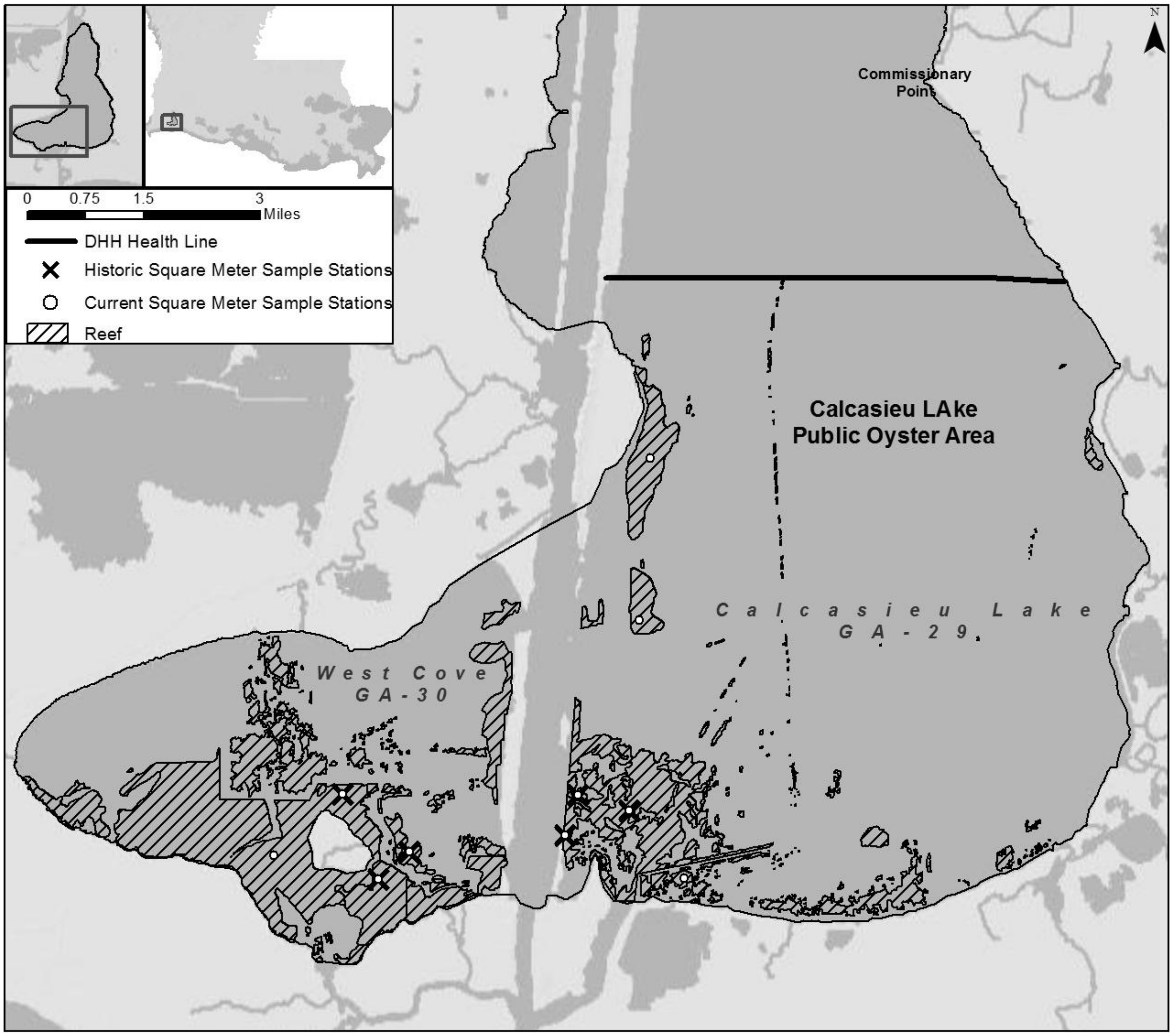


Figure 7.2. Oyster habitat (Bottom type IIIB) coverage within the Calcasieu Lake Public Oyster Area as delineated by side-scan sonar water bottom assessments in 2008 and 2011.

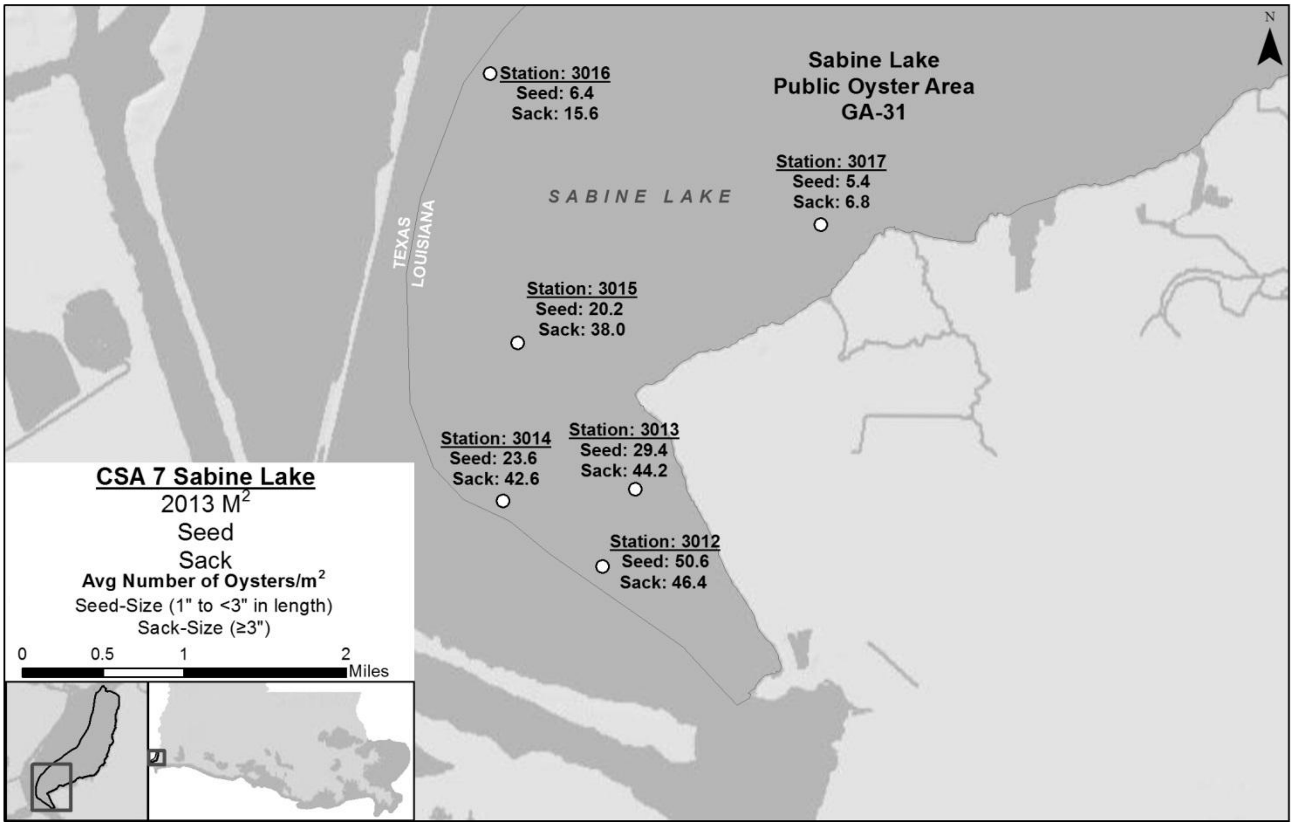


Figure 7.3. The 2013 oyster square meter sampling stations and results within the Sabine Lake Public Oyster Area.

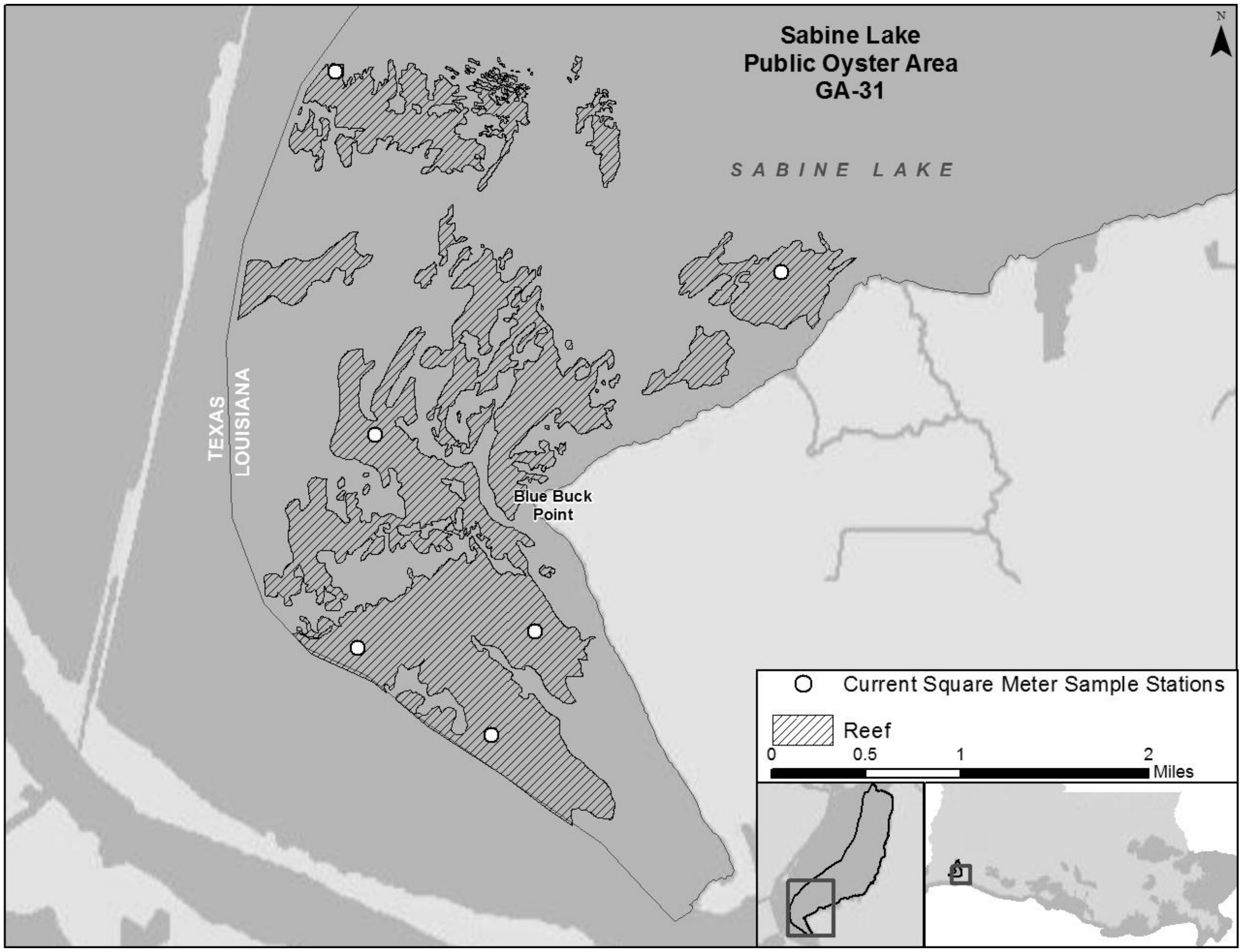


Figure 7.4. Oyster habitat (Bottom type IIIB) coverage within the Sabine Lake Public Oyster Area as delineated by side-scan sonar water bottom assessment in 2008.

Table 7.1. 2013 oyster availability estimate in Coastal Study Area (CSA) 7. Growing area (GA) 29 = Calcasieu Lake east side; GA 30 = West Cove of Calcasieu Lake; GA 31 = Sabine Lake.

PUBLIC OYSTER AREA	BOTTOM TYPE IIIB	REEF ACREAGE	SQUARE METERS	SEED OYSTERS PER M^2	SACK OYSTERS PER M^2	SACKS OF SEED OYSTERS	SACKS OF SACK OYSTERS
GA29	REEF	1,435.8	5,810,424.156	0.00	0.00	0.0	0.0
	EXPOSED SHELL	526.5	2,130,650.730	0.00	0.00	0.0	0.0
GA30	REEF	1,119.6	4,530,819.672	2.50	5.50	31,464.0	138,441.7
	EXPOSED SHELL	2,268.2	9,178,997.124	1.10	0.60	28,046.9	30,596.7
GA31	REEF	1,041.0	4,212,739.620	30.95	42.80	362,178.6	1,000,525.7
	EXPOSED SHELL	438.5	1,774,530.570	5.90	11.20	33,026.0	110,415.2
TOTALS						**454,715.5**	**1,279,979.3**

Table 7.2. Short term oyster assessments and percentage change in Coastal Study Area (CSA 7). Growing area (GA) 29 = Calcasieu Lake east side; GA 30 = West Cove of Calcasieu Lake; GA 31 = Sabine Lake.

	SACK OYSTERS (≥ 3")			SEED OYSTERS (< 3")		
YEAR	GA29	GA30	GA31	GA29	GA30	GA31
2008	752,061.9	142,199.9	NA	449,720.0	212,483.3	NA
2009[1]	612,687.3	711,613.6	NA	191,435.5	422,520.6	NA
2010[1]	23,540.1	689,375.7	478,985.9	8,545.3	605,983.5	436,409.4
2011[2]	27,007.8	594,744.1	1,031,976.2	52,831.9	308,927.2	406,141.1
2012	0.0	236,439.5	890,693.9	0.0	85,171.2	552,007.6
AVERAGE	**392,726.1**	**450,469.5**	**755,481.1**	**260,142.9**	**377,496.2**	**421,275.3**
2013	0.0	169,038.4	1,110,940.9	0.0	59,510.9	391,261.2
% CHANGE FROM AVE.	-100.0	-62.5	+47.1	-100.0	-84.2	-7.1
% CHANGE FROM 2012	0.0	-28.5	+24.7	0.0	-30.1	-29.1

1 - assessed using updated reef acreage from ENCOS (3,907.1) in 2008.
2 - assessed using updated reef acreage from ENCOS (2008) and Bio-West (2011).

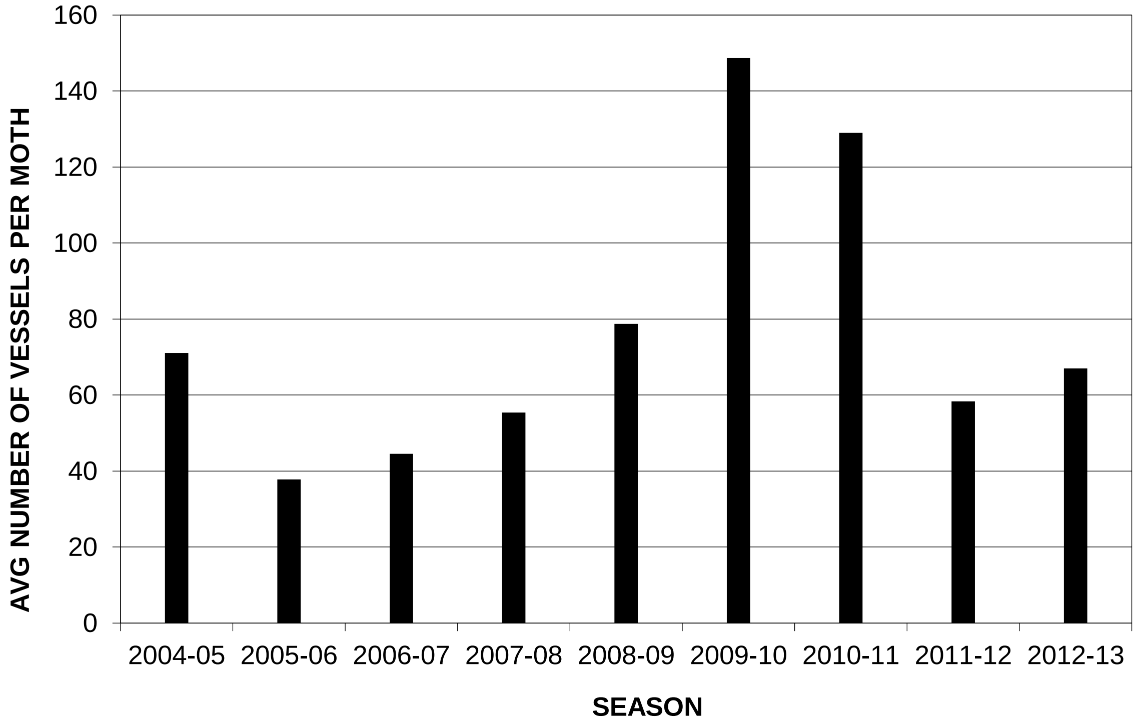


Figure 7.8. Monthly average of boats landing oysters from Calcasieu Lake.

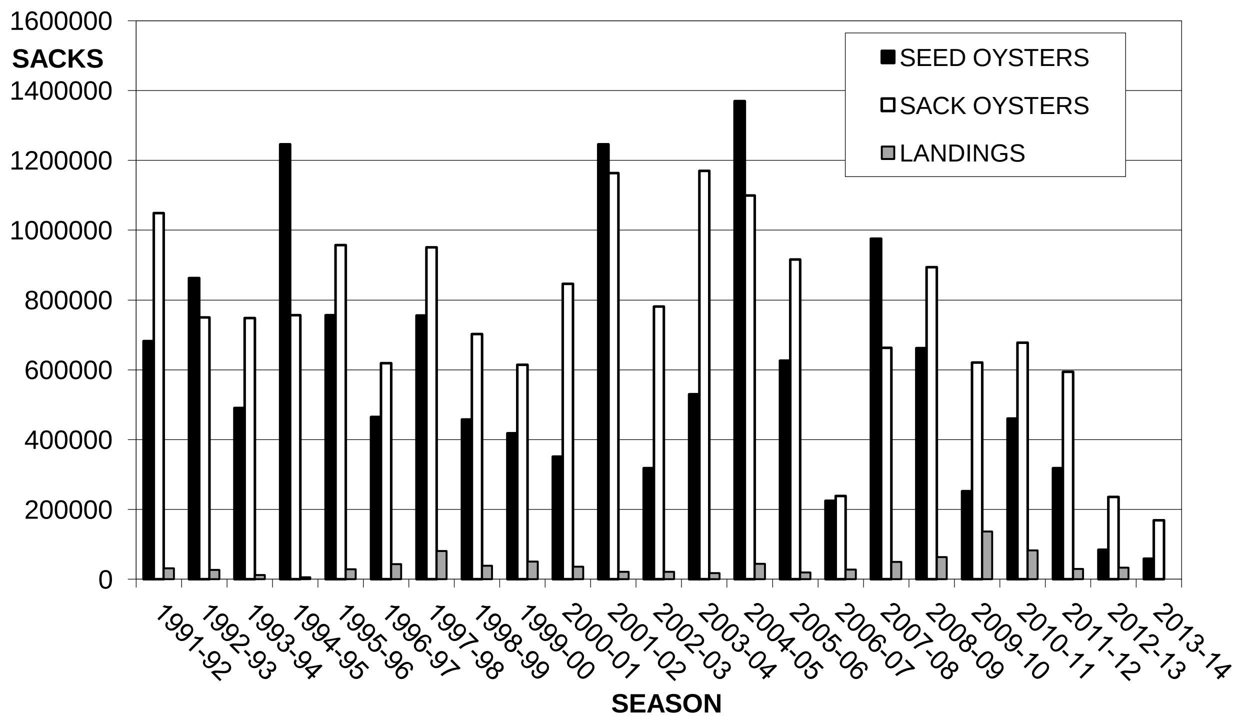


Figure 7.9. Calcasieu Lake oyster availability and landings.

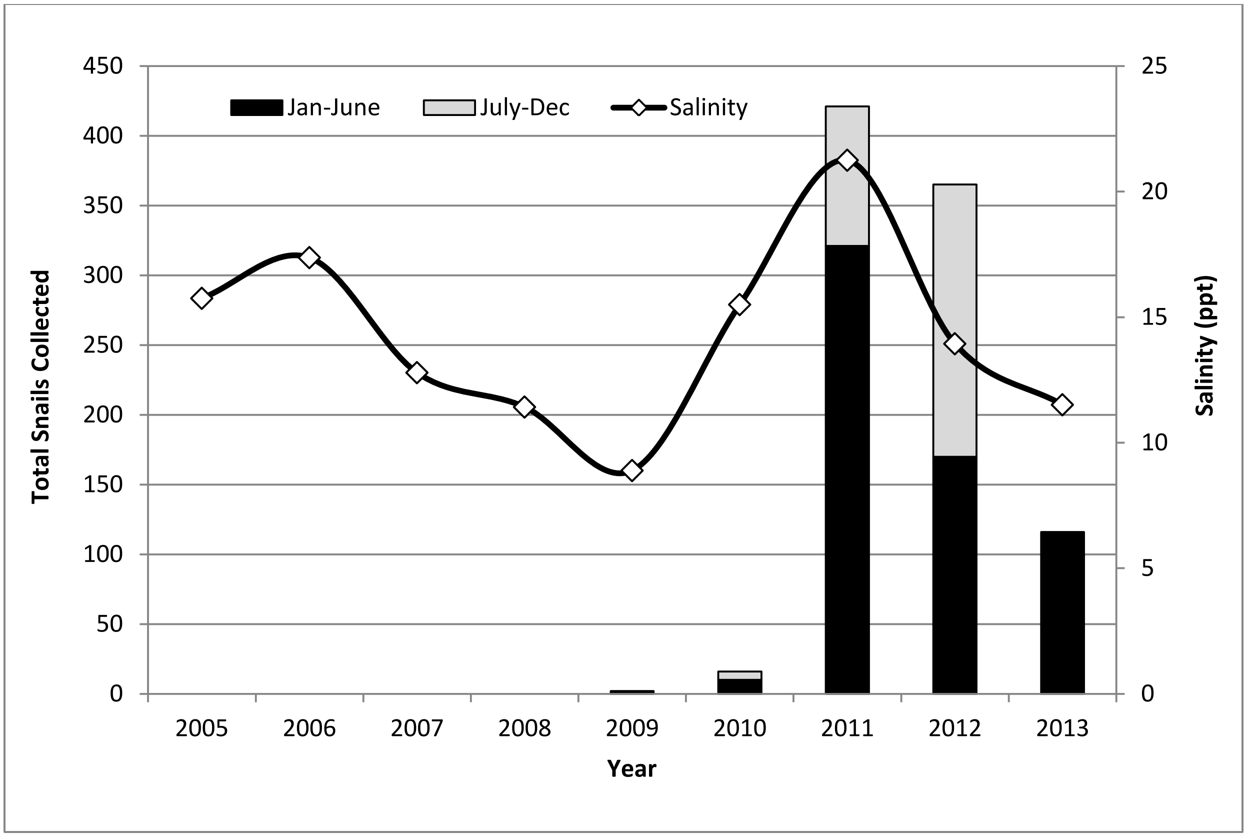


Figure 7.10. Total oyster drills (*Stramonita haemastoma*) taken in dredge samples from Calcasieu Lake during the January 2005 through June 2013 time period. Salinity data represents annual average salinity at the U. S. Geological Survey data collection platform located in mid-Calcasieu Lake during the same time period. Bars represent snail numbers and line represents salinity.

Table 7.3. Historical stock assessments and landings (in sacks) for Calcasieu Lake.

SEASONS	STOCK ASSESSMENT		ESTIMATED SACKS HARVESTED
	MARKETABLE	TOTAL	
1963	-	-	210,160
1967-74	-	-	NO COMMERCIAL LANDINGS
1975-76	142,726	441,183	40,000
1976-77	694,420	869,475	100,000
1977-78	483,673	621,885	141,976
1978-79	-	-	75,000
1979-80	676-333	979,613	125,000
1980-81	355,664	705,117	150,000
1981-82	608,110	988,575	-
1982-83	-	-	50,000-75,000
1983-84	-	-	150,000
1984-85	125,407	644,788	-
1985-86	315,160	537,760	27,400
1986-87	589,940	1,217,959	200,000
1987-88	796,950	2,703,647	125,000
1988-89	463,331	1,036,580	50,000
1989-90	172,046	640,892	40,000
1990-91	408,961	1,268,962	50,000
1991-92	1,048,882	1,731,367	31,383[1]
1992-93	749,915	1,612,736	27,328
1993-94	748,281	1,238,783	12,818
1994-95	756,525	1,246,480	6,134
1995-56	956,926	1,298,379	29,082
1996-97	618,767	1,083,866	43,441
1997-98	950,979	1,706,510	80,735
1998-99	702,371	1,160,115	39,202[2]
1999-00	614,145	1,032,117	58,960
2000-01	846,176	1,197,311	35,881
2001-02	1,163,750	2,409,482	21,297
2002-03	781,676	1,100,257	21,386
2003-04	1,169,997	1,700,663	18,196
2004-05	1,099,236	2,468,560	44,293
2005-06[3]	915,625	1,541,893	19,327
2006-07[4]	238,945	463,623	28,341
2007-08	662,747	1,638,496	49,529
2008-09	894,262	1,556,465	63,948[5]
2009-10[6]	621,006	873,099	137,074
2009-10[7]	1,398,437	1,972,920	
2010-11[8]	712,916	1,327,445	82,896
2011-12	594,744	903,671	29,666
2012-13	236,439	321,611	33,326
2013-14	169,038	228,549	

1 – STARTED USING DEALER REPORTS FOR LANDINGS.
2 – THE 1999 PORTION OF THE LANDINGS WAS DERIVED FROM PRELIMINARY TRIP TICKET DATA.
3 – HURRICAN RITE MADE LANDFALL ON 9/23/05 IN CAMERON PARISH, DELAYING SEASON OPENING, LIMITING THE NUMBER OF FISHERMEN AND BUYERS.
4 – A SEWAGE LINE BREAK IN BAYOU D'INDE CLOSED THE SEASON IN FOR THE ENTIRE MONTH OF APRIL, LIMITING THE LANDINGS.
5 – NO DATA WAS AVAILABLE FOR OCT.2008.
6 – ASSESSMENT USING THE REGULAR REEF ACREAGE.
7 – ASSESSMENTS BEGINNING IN THIS YEAR ARE USING THE UPDATED REEF ACREAGE FROM ENCOS (2008).
8 – BEGINNING IN THIS YEAR, ASSESSMENTS USE THE UPDATED REEF ACREAGE (2008) AND DATA FROM FIVE REPLICATES INSTEAD OF TWO.

Table 7.4. Total days that Calcasieu Lake was open to harvest as a percentage of season. Growing area (GA) 29 = Calcasieu Lake east side; GA 30 = West Cove of Calcasieu Lake

SEASON		TOTAL DAYS	EAST SIDE CALCASIEU LAKE		WEST COVE CALCASIEU LAKE	
			OPEN DAYS	PERCENT	OPEN DAYS	PERCENT
1991-92		199	114	57	114	57
1992-93*		165	137	83	76	46
1993-94		181	146	81	84	46
1994-95		181	90	50	9	5
1995-96		188	175	93	115	61
1996-97		197	149	76	114	58
1997-98		197	139	71	96	49
1998-99		197	135	69	120	61
1999-00		197	197	100	182	92
2000-01		198	180	95	106	53
2001-02		198	158	80	61	31
2002-03		198	146	74	66	33
2003-04		199	172	87	126	63
2004-05		198	168	85	68	34
2005-06	GA29	198	187	94		
	GA30	205			165	40
2006-07	GA29	181	118	65		
	GA30	197			70	35
2007-08	GA29	182	165	91		
	GA30	199			131	66
2008-09	GA29	198	183	92		
	GA30				125	63
2009-10	GA29	198	157	79		
	GA30				80	40
2010-11	GA29	131	131	100		
	GA30	196			186	95
2011-12	GA29	Closed	0	-		
	GA30	175			91	52
2012-13	GA29	Closed	0	-		
	GA30				111	61

1 - 92-93 SEASON STARTED USING CALCASIEU RIVER GAUGE AT KINDER FOR DHH CLOSURES.
2 – STARTING WITH THE 2005-06 SEASON, THE LAKE WAS DIVIDED INTO TWO CONDITIONAL MANAGED AREAS (CMA),WERE MANAGED SEPERATELY AND MAY HAVE DIFFENENT LENGTH SEASONS.
3 – STARTING WITH THE 2010-11 SEASON THE CONDITIONAL MANAGED AREAS WERE CHANGED TO GROWNING AREAS (GA).

Table 7.5. Salinity and temperature data from Coastal Study Area (CSA 7) during May-July 2013. Growing area (GA) 29 = Calcasieu Lake east side; GA 30 = West Cove of Calcasieu Lake; GA 31 = Sabine Lake.

	GA29		GA30		GA31		LONG TERM (CALCASIEU LAKE)[1]	
MONTH	AVE. SAL.	AVE. TEMP.	AVE. SAL.	AVE. TEMP.	AVE. SAL.	AVE. TEMP.	AVE. SAL.	AVE. TEMP.
MAY DREDGE SAMLES	20.1	24.6	16.9	22.6	13.4	24.2	11.0	25.6
JUNE DREDGE SAMPLES	18.8	30.7	17.7	29.0	10.4	29.3	11.6	28.7
JULY SQ. MTR. ASSESSMENT	18.3	30.0	19.9	28.5	14.1	29.7	12.3	29.6

1 – Longterm is from Calcasieu Lake - 16'trawl data (May: WW19-22; June: WW 23-26; July: WW27-30)

Table 7.6. Calcasieu Lake oyster season dates since 2004. Growing area (GA) 29 = Calcasieu Lake east side; GA 30 = West Cove of Calcasieu Lake

		REGULAR SEASON							TOTAL DAYS IN SEASON
		DATES			DHH HEALTH CLOSURES				
					EAST SIDE CALCASIEU LAKE		WEST COVE CALCASIEU LAKE		
		OPEN DATE	CLOSED DATE	TOTAL DAYS	DAYS OPEN	DAYS CLOSED	DAYS OPEN	DAYS CLOSED	
2004-05		10-15	4-30	198	168	30	68	130	198
2005-06	GA29	10-15	4-30	198	187	11			198
	GA30	10-8	4-30	205			165	40	205
2006-07	GA29	11-1	4-30	181	118	63			181
	GA30	10-16	4-30	197			70	127	197
2007-08	GA29	11-1	4-30	182					182
	GA30	10-15	4-30	199					199
2008-09	GA29	10-15	4-30	198	183	15			198
	GA30						125	73	
2009-10	GA29	10-15	4-30	198	157	41			198
	GA30						80	118	
2010-11	GA29	11-15	3-25[2]	131	131	0			131
	GA30[1]	10-15	4-30	196			186	10	196
2011-12[3]	GA29[4]	CLOSED	-	0	0	0			0
	GA30	11-1	4-30	175			91	84	175
2012-13	GA29	CLOSED	-	0	0	0			0
	GA30	11-1	4-30	181			111	70	181

1 – FROM 10-15 THROUGH 11-14, THE SACK LIMIT WAS 20; SACK LIMIT REVERTED TO 10 FOR THE REMAINDER OF THE SEASON IN BOTH GROWING AREAS.
2 – GA29 CLOSED DUE TO HEAVY HARVEST PRESURE OF THE RESOURCE; SEE LDWF NEWS RELEASE 3/22/11.
3 – OYSTERING FROM CALCASIEU LAKE FOR THE 2011-12 SEASON WAS BY SPECIAL PERMIT ONLY, SEE NEWS RELEASE FROM 7/7/11 AND 9/15/11.
4 - GA 29 WAS CLOSED. SEE NEWS RELEASE FROM 9/1/2011.

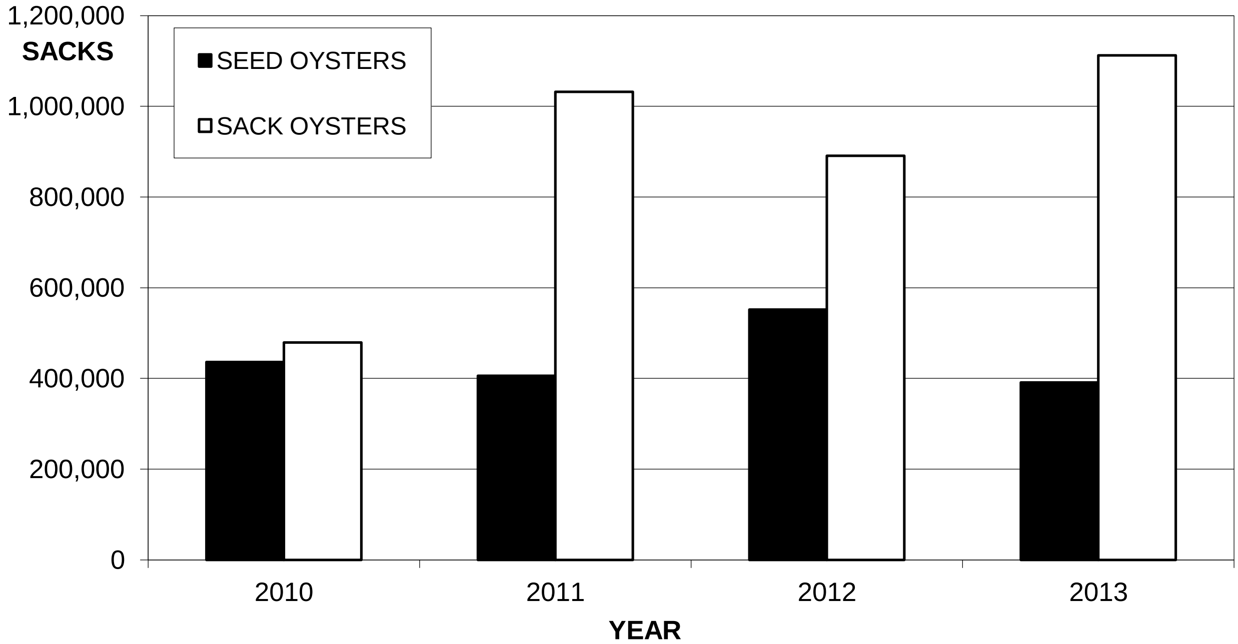


Figure 7.11. Sabine Lake oyster availability.

Levels of the parasite *Perkinsus marinus* in sack and seed oysters: Louisiana Public Seed Grounds, Summer 2013

by

Thomas M. Soniat, Ph.D.

3 August 2013

Among the most significant causes of oyster mortality is the parasite *Perkinsus marinus* which is responsible for annual mortality rates that exceed 50% in many populations of adult eastern oysters, *Crassostrea virginica*. *Perkinsus marinus* was described in 1950 by John Mackin, Malcolm Owen and Albert Collier as *Dermocystidium marinum* – hence the common name "dermo" which is still in use (Mackin et al. 1950).

The discovery of the parasite was the result of investigations (funded by a consortium of oil companies and directed by Texas A&M University) of the impact of oil and gas activities on the Louisiana oyster industry (Mackin and Hopkins, 1962). Extensive studies were conducted on the effects of crude oil, bleed water, natural gas, drilling mud and seismographic surveys. It was ultimately realized that none of these pollutants or activities explained the widespread mortalities of oysters that were observed. It is now known that the parasite is a major cause of oyster mortality from Maine to Mexico (Soniat, 1996).

The critical environmental factors which favor the proliferation of the parasite are high water temperatures and high salinities. Thus infections are more intense in the late summer, on the seaward side of estuaries and during droughts. Drought conditions on the Gulf Coast are associated with the La Niña phase of El Niño Southern Oscillation; however, increases in prevalence (percent infection, PI) precede sharp increases in intensity (weighted prevalence, WP) and epizootics of dermo in Louisiana can lag La Niña events by about 6 months (Soniat et al., 2005). Management techniques to minimize disease and increase oyster harvest include moving infected oysters to lower salinity, early harvest of infected populations, and even freshwater diversion into high-salinity estuaries. Because of the key role of dermo as a cause of oyster mortality, the success of oyster farming depends on the ability to manage oyster populations in the presence of high levels of disease (Soniat and Kortright, 1998).

The standard assay for determining the level of parasitism is the fluid thioglycollate method (Ray, 1966). A small piece tissue is removed and assayed for disease after incubation in fluid thioglycollate and antibiotics for one week. *P. marinus* intensity is scored using a 0-to-5 scale developed by Mackin (1962), where 0 is no infection and 5 is an infection in which the oyster tissue is almost entirely obscured by the parasite. Calculations are made of percent infection (PI) and weighted prevalence (WP), which is the sum of the disease code numbers divided by the total number of oysters in the sample. A WP of 1.5 could be considered a level at which disease-related mortalities are occurring (Mackin 1962, Bushek et al. 2012). Mackin (1962) claims a population of live oyster with a weighted prevalence of 2.0 “contains an intense epidemic, and more than half of the population may be in advanced stages of the disease, with all of the individuals infected.”

Oysters for the summer 2013 study were collected from 20 sites across coastal Louisiana. Samples were taken from Cabbage Reef (CR) and Three Mile Pass (TM) in Mississippi Sound; Mozambique Point (MP). Lonesome Island (LI), North Black Bay (NB), South Black Bay (SB), Telegraph Point (TP), Bay Crabe (BC), and Bay Gardene (BG) in the Breton Sound area; upper Hackberry Bay (HB) in the Barataria system; Lake Felicity (LF) and Lake Chien (LC) in the Terrebonne Bay region; Grand Pass (GP) and Old Camp (OC) in Sister Lake; Rat Bayou (RB) and Buckskin Bayou (BB) in Bay Junop; Middle Reef (MR) and Indian Point (IP) in Vermilion Bay; Northeast Rabbit Island (NE) in Lake Calcasieu; and a single Sabine Lake (SL) site.

An attempt was made to assay 10 market-sized (≥ 75 mm) oysters and 10 seed (25-74 mm) oysters from each site. However, in some cases insufficient numbers of oysters were available to satisfy that standard (Table 1).

The length of oysters was measured to the nearest mm; mantle tissue was removed from each oyster, incubated at room temperature in fluid thioglycollate for about a week, and assayed according to the standard Ray (1966) technique. The level of infection (disease code) was scored from 0 to 5, where 0 is no infection and 5 is near total coverage of the oyster tissue by the parasite. Weighted prevalence (WP) was calculated by summing the disease code values and dividing by the number of oysters in the sample.

Weighed prevalence (WP) and percent infection (PI) results are shown in Table 1. As compared to last year, this year’s WP results showed increases in disease in oysters east of the Mississippi River (TM, LI, SB, BG), LF (Terrebonne), and Sister Lake (GP, OC). Sack oysters showed an increase in WP at NE (Lake Calcasieu) and SL (Sabine Lake). In contrast, decreases in WP were found for sack and seed at HB (in Barataria Bay) and LC (Terrebonne). Buckskin Bayou (Bay Junop) showed a decrease in WP of sack oysters, whereas IP (Vermilion) and SL (Sabine Lake) showed increases in seed oysters. Increases of disease levels in seed oysters (LC, OC, IP, and SL) suggest an upward trend in those areas.

Disease levels remain low in areas influenced by the Mississippi and Atchafalaya Rivers. There is an overall upward trend in disease west of the Atchafalaya, with highest levels found in Lake Calcasieu. Records of disease levels from this year and previous years are available from Oyster Sentinel (www.oystersentinel.org).

Table 1. Percent Infection (PI) and Weighted Prevalence (WP) of seed and market-size oysters from Louisiana Public Seed Grounds: Summer 2013. Date is collection date, T = temperature, S = salinity, PI = percent infection, WP = weighted prevalence, NS = number of seed oysters assayed, NM = number of market oysters assayed.

Station	Date	T (^{o}C)	S (ppt)	Seed PI	Seed WP	NS	Market PI	Market WP	NM
Cabbage Reef	7/17/13	28.0	20.4	0	0	10	10	0.03	10
Three Mile Pass	7/17/13	28.2	17.8	10	0.03	10	40	0.17	10
Mozambique Point	7/17/13	28.3	10.2	30	0.10	10	25	0.08	4
Lonesome Island	7/15/13	29.7	11.6	0	0	10	20	0.10	10
North Black Bay	7/16/13	28.2	8.9	0	0	10	no data	no data	0
South Black Bay	7/17/13	28.4	8.4	22	0.07	9	25	0.08	4
Telegraph Point	7/17/13	28.4	5.6	40	0.13	10	no data	no data	0
Bay Crabe	7/16/13	28.0	5.8	0	0	3	0	0	4
Bay Gardene	7/11/13	29.2	6.6	20	0.07	10	20	0.13	10
Hackberry Bay	7/3/13	29.8	7.8	10	0.03		0	0	10
Lake Felicity	7/15/13	29.5	14.5	no data	no data	0	50	0.70	10
Lake Chien	7/15/13	29.6	12.9	0	0	10	20	0.07	10
Grand Pass	7/15/13	29.0	8.9	50	0.20	10	20	0.07	10
Old Camp	7/15/13	29.5	13.6	20	0.07	10	20	0.10	10
Buckskin Bayou	7/15/13	29.2	7.0	0	0	10	0	0	10
Rat Bayou	7/15/13	29.1	16.0	40	0.20	10	50	0.47	10
Middle Reef	7/9/13	28.2	2.3	20	0.07	10	10	0.03	10
Indian Point	7/9/13	28.6	3.9	10	0.03	10	0	0	10
Northeast Rabbit	7/8/13	28.2	20.0	50	0.17	10	100	1.10	10
Sabine Lake	7/8/13	29.8	26.9	60	0.63	10	80	0.50	10

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Synopsis of the Second Annual Louisiana Oyster Stock Assessment Workshop

29 August 2013

University of New Orleans

Compiled by

Thomas M. Soniat

Oyster Research Laboratory

Department of Biological Sciences

University of New Orleans

9/23/2013

Second Annual Louisiana Oyster Stock Assessment Workshop:

Participants and support staff

Thomas Soniat
Department of Biological Sciences
University of New Orleans

Eric Powell
Gulf Coast Research Laboratory
University of Southern Mississippi

Patrick Banks
Louisiana Department of Wildlife and Fisheries

Brian Lezina
Louisiana Department of Wildlife and Fisheries

Pete Vujnovich
Louisiana Oyster Task Force

Susan Colley
Department of Biological Sciences
University of New Orleans

John Finigan
Department of Computer Sciences
University of New Orleans

Nathan Cooper
Department of Computer Sciences
University of New Orleans

Josh Gallegos
Department of Computer Sciences
University of New Orleans

The Second Annual Stock Assessment Workshop was held on August 29, 2013 at the University of New Orleans. The purpose of the Workshop was to evaluate the status of the oyster stock in public oyster areas, estimate sustainable harvests for the upcoming oyster season in those public areas, and review and propose management and scientific research recommendations.

Background and Methods

Oyster density and oyster size from the 2013 Louisiana Department of Wildlife and Fisheries (LDWF) Stock Assessment from all the public oyster areas in all Coastal Study Areas (CSAs) were input using an automated data entry form (Soniat et al. 2013). The digitized data were queried by the numerical model through a model set-up utility. Oyster density and size were inputs into a mathematic model to evaluate the number of sacks of seed and sack oysters that could be removed during the 2013/14 season with no net loss of shell. Primary model components calculate growth, natural mortality, fishing mortality, cultch density and sacks of seed and sack (market) oysters fished (Figure 1).

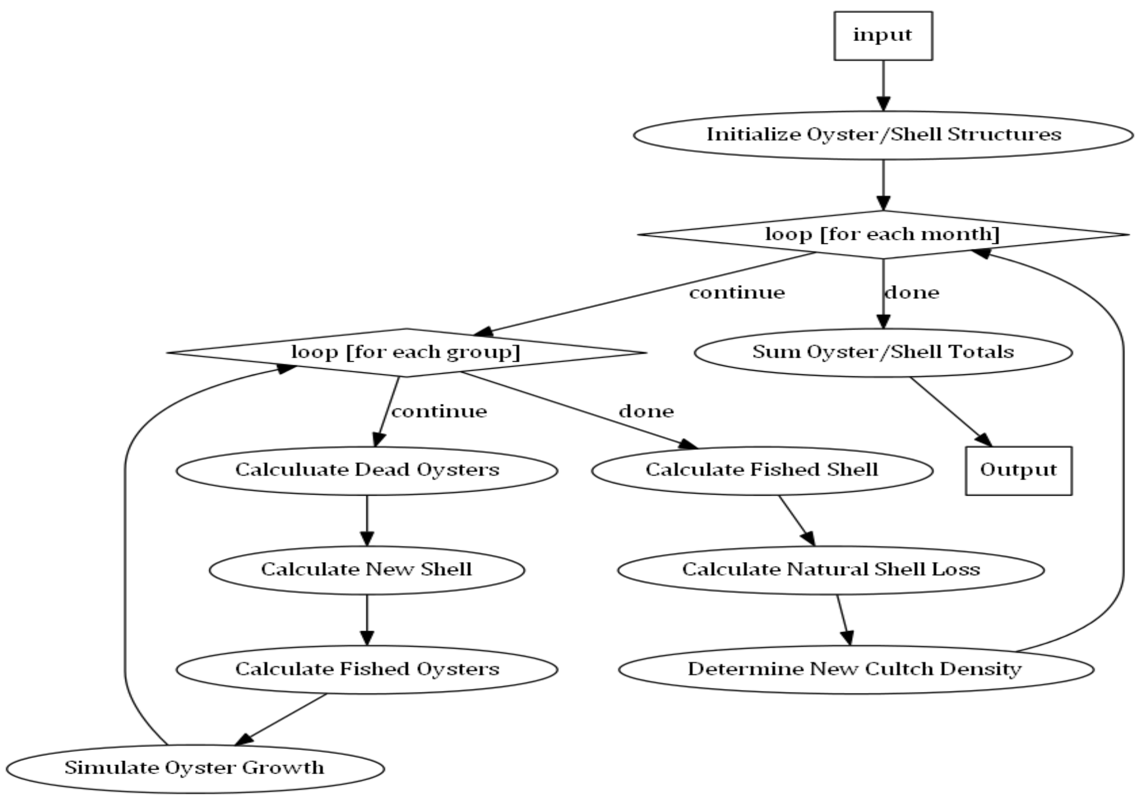

Figure 1. Schematic of major oyster model processes (from Soniat et al. 2012)

Oysters that are not lost to natural mortality or are removed by fishing grow into new size classes over time. Natural mortality provides new shell to the reef, whereas fishing removes it. Natural shell loss occurs from taphonomic processes, mostly dissolution and biodegradation. Change in cultch density is thus a function of initial cultch density, initial population numbers, size-class distribution, shell growth, natural mortality, fishing mortality, and natural shell loss. Fishing rates and times are adjusted to achieve sustainable harvest; i.e., harvests that result in no net loss of shell. (Model details are provided by Soniat et al. 2012, 2013.)

The 2012 Stock Assessment (LDWF 2012) included, for the first time, precise measurements on the quality and quantity of the cultch. Brown (surface) and black (muddy, buried) substrate were collected from 1-m^2 grids and weighed. These measurements were repeated during the 2103 Stock Assessment sampling. The substrate categories are: muddy oyster shell, brown oyster shell, muddy limestone, brown limestone, muddy clamshell, brown clamshell, muddy concrete, brown concrete, muddy other substrate, and brown other substrate. Although the quantity (g/m^2) of the various substrate types were sampled in the 2013 Stock Assessment, only brown shell was used in the present simulations.

Status of the Stock

The 2013 stock assessment sampling by LDWF indicated an approximately 27% increase in statewide oyster stocks. This increase was driven largely by substantial gains in seed oyster stocks located east of the Mississippi River in CSAs 1-North and 1-South. Refer to the 2013 Oyster Stock Assessment report for additional information.

Sustainable Harvests

Simulations were conducted to estimate sustainable harvests from all CSAs[1] (Fig. 2), and by summation that of all Public Oyster Areas.

[1]Model set-up uses the previous seven CSA classification: CSA 1 Mississippi Line to Mississippi River Gulf Outlet, CSA 2 MRGO to Empire, CSA 3 Empire to Bayou Lafourche, CSA 4 BL to Caillou Boca, CSA 5 CB to Atchafalaya River, CSA 6 AR to Freshwater Bayou, CSA 7 FB to Sabine Pass. The new CSA system combines CSA 2 into CSA 1, with the former CSA 1 called CSA 1N (1 North) and the former CSA 2 called CSA 1S (1 South); CSA 3 remains unchanged; CSA 4 is combined with CSA 5, with the former CSA 4 designated as CSA 5E (5 East) and the former CSA 5 now called CSA 5W (5 West); CSAs 6 and 7 remain unchanged.

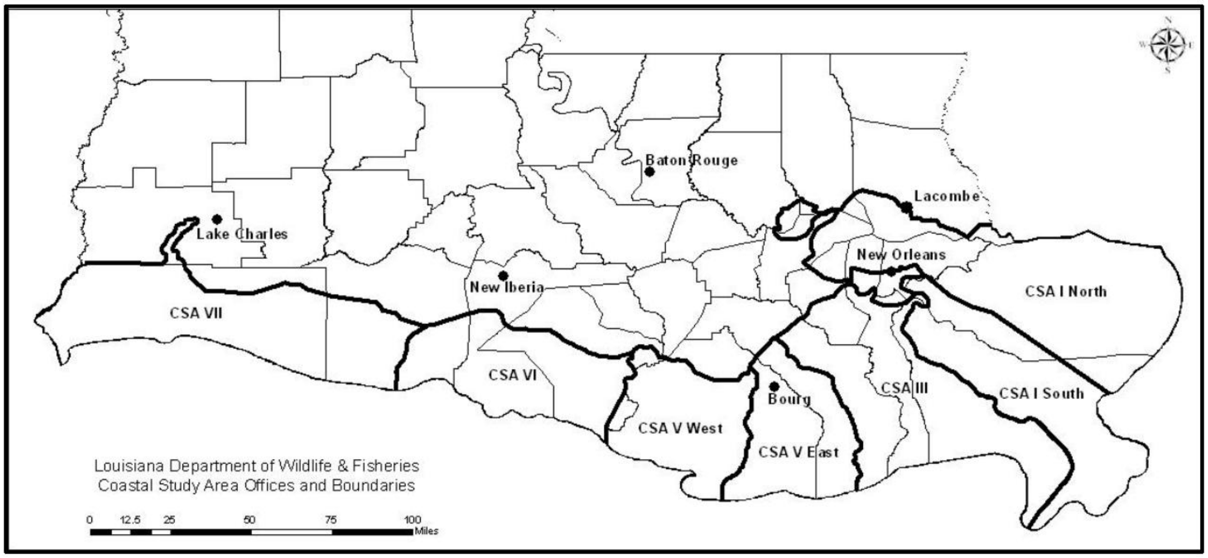

Figure. 2. Boundaries of LDWF Coastal Study Area (new designation).

Fishing rates were varied to identify a rate that resulted in no net loss of cultch. Initial simulations were conducted for all stations (reefs and cultch plants) without fishing (Table 1); those with a gain of cultch mass *(negative* cultch loss value) were deemed potentially "fishable" (Figs. 3 - 8). Reefs and cultch plants that were deemed "fishable" and which might be opened for harvest were simulated to determine a sustainable Total Allowable Catch (hereafter simply referred to as TAC). Sustainability in simulations is achieved by manipulating fishing effort to achieve no net loss of cultch. The temporal distribution of fishing, fishing effort (approximate monthly effort as a percent of total effort) and fishing type (sack, seed) is informed by recent commercial fishing practices provided by LDWF (Table 2).

Table 3 shows the simulated TAC for sack and seed oysters for the various CSAs and the statewide total, as summarized below.

- From CSA 1N, Petit Island, Johnson Bayou, and East and West Karako showed a positive shell balance and is planned to be open to fishing (Table 1, Fig. 3), thus they are included in the assessment of TAC. CSA 1N supports a TAC of 9,936 sacks of sack oysters and 6,464 sacks of seed oysters (Table 3).

- The CSA 1S stations of Snake Island, Jessie Island, Lonesome Island, West Bay Crabe and Horseshoe Reef show a positive shell balance (Table 1, Fig. 4), are planned to be open for fishing (Table 1), and are thus included in the estimation of regional TAC (Table 3). CSA 1S TAC is estimated to be 10,098 sacks of sack oysters and 1,416 sacks of seed.
- In CSA 3, the Lower, Middle and Upper Hackberry Bay stations, the 2004 North and South Hackberry Bay Shell Plants and the 2008 and 2012 cultch plants in Hackberry Bay showed a positive shell balance without fishing (Fig. 5); of those only the 2012 Cultch Plant is planned to be closed to fishing (Table 1). CSA 3 TAC is estimated to be 1,085 sacks of sack oysters and 1,349 sacks of seed (Table 3).
- None of the former CSA 4 stations (Table 1) are included in the calculation of TAC since they are planned to be closed to fishing.
- Fishable and open stations from CSA 5, used in the calculation of TAC, include the 2009 Sister Lake Shell plant, Mid Sister Lake, the N 94 and 95 shell plants, the Sister Lake 2004 Cultch Plant, and Walker's Point (Table 3, Fig. 6). TAC from CSA 5 is 25,573 sacks of sack oysters and 10,413 sacks of seed (Table 3).
- None of the stations in CSA 6 were considered fishable (Fig. 7). Low densities or no oysters on the reefs there resulted in shell budgets controlled by loss processes.
- The Sabine Lake stations (CSA 7) showed a shell gain without fishing (Fig. 8, Table 1); however, they are not planned to be open to fishing (Table 1) and thus not included in the estimation of TAC. Only SE Rabbit Island and the West Cove Transplant sites (Fig. 8, Table 1) were used in the determination of TAC for CSA 7. The CSA 7 TAC is 30070 sacks of sack oysters. As a general industry practice no fishing of seed oysters occurs in CSA 7 (Table 2).

In summary, the 2013 statewide estimate of TAC is 76,763 sacks of sack oysters and 19642 sacks of seed. This compares with a 2012 estimated *harvest* of 64,897 sacks of sack oysters and 13,014 sacks of seed from the public oyster areas of the state. Thus, the predicted sustainable catch for the 2013/2014 season is comparable to and greater than the actual harvest from 2012/2013 season. It should be noted that the present estimates of TAC are based on cultch stasis, not enhancements to desired endpoints (Mann etal.2009). That is, since sustainable fishing estimates are based on no net loss of cultch, a poor quality reef, before fishing remains a poor quality reef after fishing.

Review of 2012 SAW Recommendations

Stock Assessment Workshop Team 2012 recommendations (italics) are followed by a discussion of their status.

1. Conduct a trial application of the model on the public oyster grounds in Hackberry Bay. The Hackberry Bay Public Oyster Seed Reservation was used as a test site for an initial model application. Sustainable harvest estimates from Hackberry Bay generated from the 2012 stock assessment data were used to set a TAC of 7,000 sacks of seed and 4,700 sacks of sack oysters. Harvest was monitored closely by LDWF biologists and the season closed when the estimated harvest appeared to reach the projected TAC. Actual harvest as percent of TAC was 71.9% for seed and 109.6% for sack oysters. The pre-fishing average cultch density (2012 Stock Assessment) in Hackberry Bay was 842 g/m^2, whereas the post-fishing (2013 Stock Assessment) density was 2,665 g/m^2. The increase in predicted shell density may be due to a seed harvest below the sustainable threshold, the inability to sample just after the close of fishing, or model imperfections. Nonetheless, the test suggests that at harvest levels near the sustainability criteria the reefs were not diminished in cultch.

2. Determine loss rates of all cultch types (oyster shell, clamshell, limestone, concrete, mussel shell) across salinity gradients. The model presently uses a single loss rate for cultch, based on a rate appropriate to the primary substrate, namely oyster shell. However, limestone and concrete are often used for cultch plants and can make up a significant portion of the cultch, especially on newly planted bottom.

Furthermore, clamshell and mussel shell contribute to the carbonate substrate of some reefs. More information is required on the loss rates of the various substrates, especially how they vary across the salinity gradient; however, in concert with LDWF it was determined that these studies would be cost prohibitive. (See the 2013 Recommendations.)

3. Weigh live hooked mussels as part of the Annual Stock Assessment and develop a conversion of live mussel mass to mussel shell mass. Model utility now includes the opportunity for entry of live mussel weight and dead mussel shell weight. Both measures were included in the 2013 Stock Assessment. A conversion of whole animal weight to shell weight was accomplished using mussels from CSA 1 collected in the summer of 2013.

4. Incorporate specific taphonomic loss rates for oyster shell, clamshell, limestone, concrete, and mussel shell into the model. The capability of tracking specific loss rates was modeled in anticipation of parameterization to follow; however, parameterization of those rates has not been accomplished. (See the 2013 Recommendations.)

5. Parameterize oyster growth and mortality across salinity gradients. As with the parameterization of loss rates, this goal has not been accomplished.

6. Conduct a LDWF-lead Oyster Training Workshop at the LDWF laboratory at Grand Isle prior to the next Annual Stock Assessment. Successful application of the model requires a workforce trained in the collection of field data, data entry and verification, and the proper use of model output. Training of personnel should be conducted annually prior to the Annual Stock Assessment. Personnel representing all CSAs should be included. The Second Annual Oyster Training Workshop was conducted at the University of New Orleans prior to the Annual Stock Assessment. Because of the need for computer facilities and computer support staff, it was decided that the Workshop is best held in facilities of the UNO Department of Computer Science instead of remote location such as Grand Isle. The UNO Oyster Research Laboratory retains responsibility for planning and hosting Training Workshops.

7. Include another academic scientist in future Stock Assessment Workshops. Dr. Eric Powell, who has extensive experience in population modeling and oyster fisheries management, participated in the Second SAW.

2013 SAW Recommendations

1. Conduct a second trial application of the model on the public oyster grounds in Hackberry Bay. The TAC for the trial is estimated to be 1085 sacks of sack oysters and 1349 sacks of seed (Table 3). This is equivalent to the CSA 3 estimate since it incorporates the Lower, Middle and Upper Hackberry Bay stations, the 2004 North and South Hackberry Bay Shell Plants, and the 2008 cultch plant (Table 1). Harvest is to be monitored and the season closed when the estimated TAC is achieved. The metric for success is no net loss of cultch. (The 2013 Stock Assessment cultch density for CSA 3 is 2,665 g/m^2.)

2. Determine the loss rate of oyster shell from existing metrics. The rate of shell loss can be calculated from oyster cultch density, numbers, size, and mortality. With the exception of mortality, these metrics are provided by Annual Stock Assessment. Determine mortality rates of large oysters (> 2.5 inches) from existing sources (see below).

3. Assign loss rates to specific cultch types and include all cultch types in future simulations. Recommended annual loss rates are: oyster shell 10%, *Rangia* shell 30%, mussel shell 80%, limestone 1%, concrete 0.1%.

4. Determine growth and mortality along salinity gradients. Funding should be sought to carry out a substantial program to obtain good growth and mortality data. When and where available, data from existing LDWF Nestier tray studies should be used to determine growth and mortality. The analysis of the change in numbers of oysters in identifiable cohorts of oysters from various salinity regimes can be used to determine mortality.

4. Historical Stock Assessment data should be digitized by entry into the existing model database.

5. A Third Annual Stock Assessment Workshop should be scheduled on a Monday or Tuesday during the third week of August, 2014.

TABLE 1.

Regions, station names, numbers, codes and associated reef size (acres). Negative values for cultch loss indicate a shell gain. (NULL = no data). Reefs showing a shell gain were deemed fishable (indicted by TRUE in the Fishable column). Reefs open for fishing are indicated by TRUE in the Open column. Fishable and open reefs were simulated to determine sustainable catch, as indicated by TRUE in the Simulated column.

Region name	Station name	Station no.	Station code	Acres	Cultch loss (%)	Fishable	Open	Simulated
CSA1	Grassy	2	NULL	2283	7.1	FALSE	TRUE	FALSE
CSA1	Halfmoon	3	NULL	2283	NULL	FALSE	TRUE	FALSE
CSA1	Petit	4	NULL	2283	-15.2	TRUE	TRUE	TRUE
CSA1	3-Mile	5	NULL	1529	7.0	FALSE	TRUE	FALSE
CSA1	Grand Pass	6	NULL	600	10.0	FALSE	TRUE	FALSE
CSA1	Cabbage Reef	7	NULL	600	7.3	FALSE	TRUE	FALSE
CSA1	Martin	9	NULL	2077	NULL	FALSE	TRUE	FALSE
CSA1	Holmes	10	NULL	2077	NULL	FALSE	TRUE	FALSE
CSA1	Turkey Bayou	11	NULL	600	4.0	FALSE	TRUE	FALSE
CSA1	Millenium Reef	12	NULL	70	10.0	FALSE	TRUE	FALSE
CSA1	Drum Bay	15	NULL	764	NULL	FALSE	TRUE	FALSE
CSA1	Morgan Harbor	16	NULL	2954	NULL	FALSE	TRUE	FALSE
CSA1	Johnson Bayou	17	NULL	200	-58.2	TRUE	TRUE	TRUE

CSA1	Shell Point	18	NULL	47	-10.8	TRUE	TRUE	TRUE
CSA1	E. Karako	19	NULL	764	-7.9	TRUE	TRUE	TRUE
CSA1	W. Karako	20	NULL	764	-8.4	TRUE	TRUE	TRUE
CSA1	Grand Banks	22	NULL	100	0.9	FALSE	TRUE	FALSE
CSA2	Snake	1	NULL	506	-5.5	TRUE	TRUE	TRUE
CSA2	Jessie	2	NULL	59	-4.2	TRUE	TRUE	TRUE
CSA2	N. Lonesome	3	NULL	896	1.8	FALSE	TRUE	FALSE
CSA2	N. Black Bay	4	NULL	157	10.0	FALSE	TRUE	FALSE
CSA2	Bayou Lost	5	NULL	118	9.4	FALSE	TRUE	FALSE
CSA2	Lonesome	6	NULL	273	-4.6	TRUE	TRUE	TRUE
CSA2	Black Bay	7	NULL	301	8.8	FALSE	TRUE	FALSE
CSA2	W. Bay Crabe	8	NULL	501	-12.1	TRUE	TRUE	TRUE
CSA2	Stone	9	NULL	461	6.8	FALSE	TRUE	FALSE
CSA2	S. Black Bay	10	NULL	145	7.5	FALSE	TRUE	FALSE
CSA2	Elephant Pass	11	NULL	339	10.0	FALSE	TRUE	FALSE
CSA2	Curfew	12	NULL	425	7.8	FALSE	TRUE	FALSE
CSA2	N. California Bay	13	NULL	109	7.4	FALSE	TRUE	FALSE
CSA2	California Bay	14	NULL	7	2.9	FALSE	TRUE	FALSE

CSA2	Telegraph	15	NULL	127	9.5	FALSE	TRUE	FALSE
CSA2	Sunrise Point	16	NULL	174	4.5	FALSE	TRUE	FALSE
CSA2	Bay Long	17	NULL	572	10.0	FALSE	TRUE	FALSE
CSA2	E. Pelican	18	NULL	782	6.5	FALSE	TRUE	FALSE
CSA2	Mangrove Point	19	NULL	937	10.0	FALSE	TRUE	FALSE
CSA2	W. Pelican	20	NULL	293	8.2	FALSE	TRUE	FALSE
CSA2	Bay Crabe	21	NULL	659	9.3	FALSE	TRUE	FALSE
CSA2	E. Bay Crabe	22	NULL	122	10.0	FALSE	TRUE	FALSE
CSA2	E. Bay Gardene	23	NULL	28	6.5	FALSE	FALSE	FALSE
CSA2	Bay Gardene	24	NULL	69	9.2	FALSE	FALSE	FALSE
CSA2	Battledore Reef	25	NULL	1419	10.0	FALSE	TRUE	FALSE
CSA2	Horseshoe Reef	26	NULL	158	-5.1	TRUE	TRUE	TRUE
CSA2	S. Lake Fortuna	27	NULL	2144	4.0	FALSE	TRUE	FALSE
CSA2	Wreck	28	NULL	2276	4.3	FALSE	TRUE	FALSE
CSA2	E. Stone	29	NULL	105	9.0	FALSE	TRUE	FALSE
CSA2	N. Lake Fortuna	30	NULL	2144	6.6	FALSE	TRUE	FALSE
CSA3	Lower Hackberry	1	NULL	5	-31.1	TRUE	TRUE	TRUE
CSA3	Middle Hackberry	2	NULL	5	-109.3	TRUE	TRUE	TRUE

CSA3	Upper Hackberry	3	NULL	5	-13.3	TRUE	TRUE	TRUE
CSA3	2004 N. Hackberry Shell Plant	6	NULL	10	-10.4	TRUE	TRUE	TRUE
CSA3	2004 S. Hackberry Shell Plant	7	NULL	25	-5.3	TRUE	TRUE	TRUE
CSA3	2004 Barataria Bay Cultch Plant	8	NULL	40	9.1	FALSE	TRUE	FALSE
CSA3	2008 Cultch Plant	9	NULL	50	-25.4	TRUE	TRUE	TRUE
CSA3	2012 Cultch Plant	10	3007	200	-9.7	TRUE	FALSE	FALSE
CSA4	Lake Felicity	1	NULL	40	1.7	FALSE	FALSE	FALSE
CSA4	Lake Chien 2004	2	NULL	15	-13.7	TRUE	FALSE	FALSE
CSA4	Lake Chien 2009	3	NULL	22	-3.5	TRUE	FALSE	FALSE
CSA5	2009 SL Cultch Plant	NULL	219	156	-38.4	TRUE	TRUE	TRUE
CSA5	Buckskin Bayou Junop	NULL	251	17	-63.4	TRUE	FALSE	FALSE
CSA5	Grand Pass	NULL	200	322	-565.9	TRUE	TRUE	TRUE
CSA5	Junop Bayou DeWest	NULL	255	33	7.0	FALSE	FALSE	FALSE
CSA5	Lake Mechant	NULL	300	30	9.3	FALSE	TRUE	FALSE
CSA5	Mid 94 Shell Plant	NULL	214	187	-33.3	TRUE	TRUE	TRUE
CSA5	Mid Bay Junop	NULL	253	73	-15.8	TRUE	FALSE	FALSE
CSA5	Mid Sister Lake	NULL	207	270	-266.6	TRUE	TRUE	TRUE
CSA5	N. 94 Shell Plant	NULL	213	139	-208.6	TRUE	TRUE	TRUE

CSA5	N. 95 Shell Plant	NULL	216	167	-113.8	TRUE	TRUE	TRUE
CSA5	Old Camp	NULL	203	220	9.7	FALSE	TRUE	FALSE
CSA5	Rat Bayou	NULL	252	33	1.8	FALSE	FALSE	FALSE
CSA5	S. 94 Shell Plant	NULL	215	117	10.0	FALSE	TRUE	FALSE
CSA5	SL 2004 Cultch Plant	NULL	218	97	-66.9	TRUE	TRUE	TRUE
CSA5	Walkers Point	NULL	202	119	-53.9	TRUE	TRUE	TRUE
CSA6	South Point	1	NULL	75	10.0	FALSE	TRUE	FALSE
CSA6	Big Charles	2	NULL	15	10.0	FALSE	TRUE	FALSE
CSA6	Indiant Point	3	NULL	50	9.1	FALSE	TRUE	FALSE
CSA6	Dry Reef	4	NULL	20	8.8	FALSE	TRUE	FALSE
CSA6	Bayou Blanc	5	NULL	15	10.0	FALSE	TRUE	FALSE
CSA6	Sally Shoals	20	NULL	5	10.0	FALSE	TRUE	FALSE
CSA6	Rabbit	21	NULL	15	10.0	FALSE	TRUE	FALSE
CSA6	Lighthouse Point	22	NULL	15	9.4	FALSE	TRUE	FALSE
CSA6	Middle Reef	23	NULL	20	10.0	FALSE	TRUE	FALSE
CSA6	N. Reef	24	NULL	5	10.0	FALSE	TRUE	FALSE
CSA7	Sabine Lake 1	NULL	3012	260	-149.2	TRUE	FALSE	FALSE
CSA7	Sabine Lake 2	NULL	3013	260	-127.2	TRUE	FALSE	FALSE

CSA7	Sabine Lake 3	NULL	3014	260	-165.5	TRUE	FALSE	FALSE
CSA7	Sabine Lake 4	NULL	3015	260	-146.1	TRUE	FALSE	FALSE
CSA7	Sabine Lake 5	NULL	3016	219	-145.8	TRUE	FALSE	FALSE
CSA7	Sabine Lake 6	NULL	3017	219	-150.9	TRUE	FALSE	FALSE
CSA7	Big Washout	1	3003	474	10.0	FALSE	FALSE	FALSE
CSA7	Little Washout	2	3004	474	10.0	FALSE	FALSE	FALSE
CSA7	Mid Lake	3	3005	474	10.0	FALSE	FALSE	FALSE
CSA7	S.E. Rabbit	4	3000	560	-140.2	TRUE	TRUE	TRUE
CSA7	N.E. Rabbit	5	3001	1134	3.2	FALSE	TRUE	FALSE
CSA7	W. Cove Trans	6	3002	560	-59.6	TRUE	TRUE	TRUE
CSA7	Long Point	10	3008	265	NULL	FALSE	FALSE	FALSE
CSA7	9 Mile	11	3009	265	NULL	FALSE	FALSE	FALSE
CSA7	2009 Cultch Plant	15	3010	14	NULL	FALSE	FALSE	FALSE
CSA7	W. Rabbit	16	3011	1134	6.2	FALSE	TRUE	FALSE

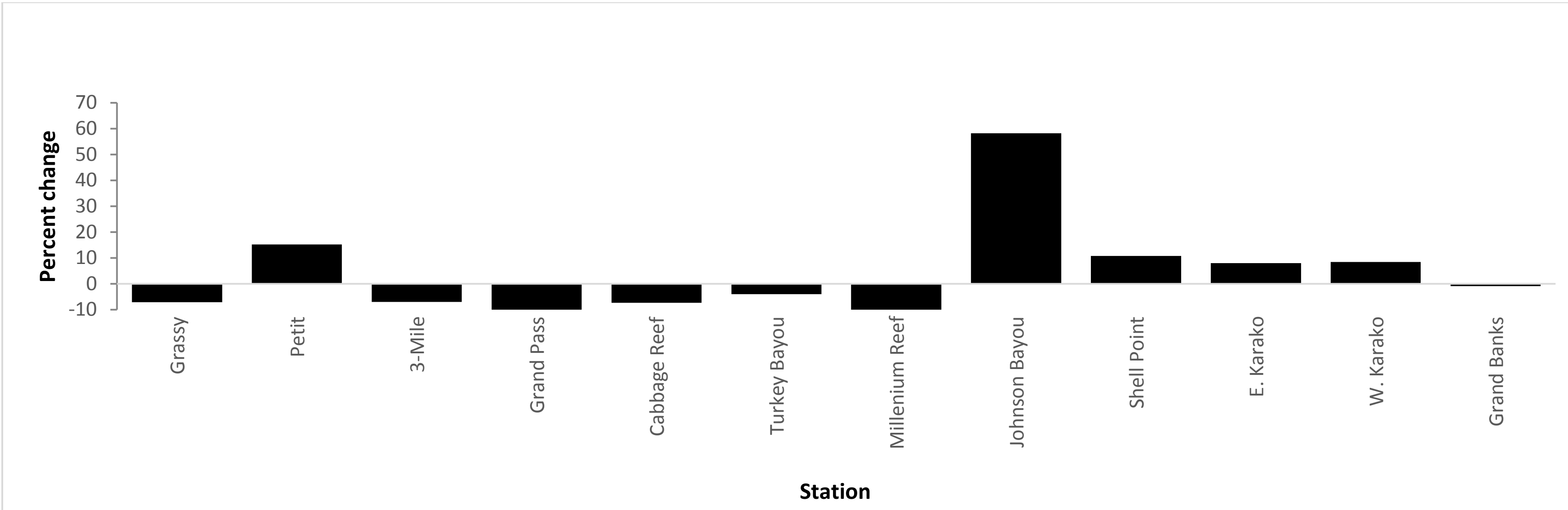

Figure 3. Initial simulations to determine percent change in cultch mass without fishing (CSA 1N). Positive change indicates that the reef or shell plant is fishable.

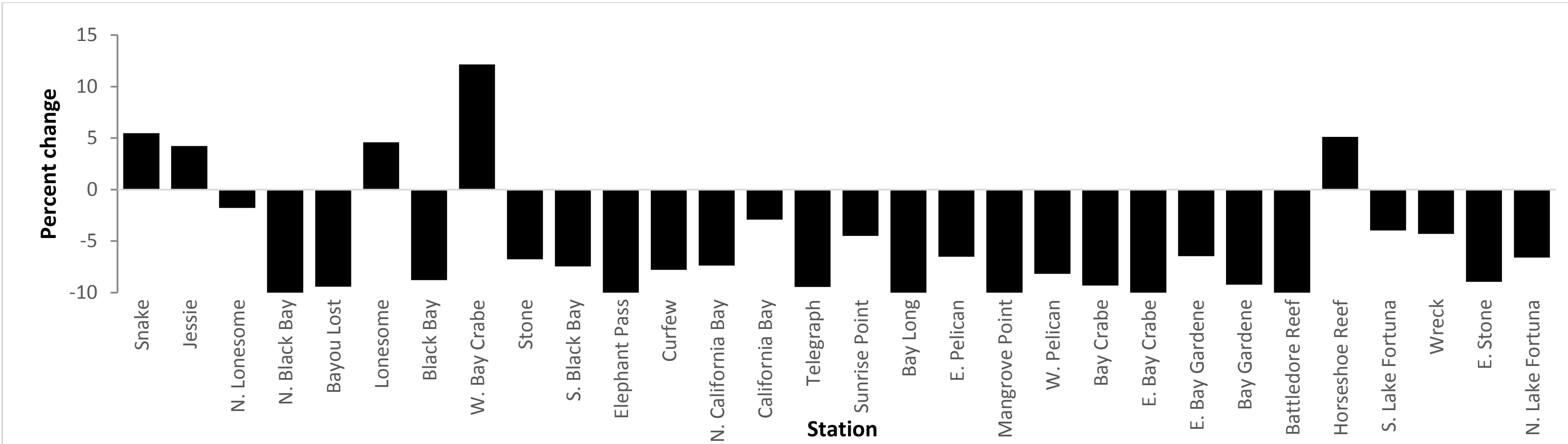

Figure 4. Initial simulations to determine percent change in cultch mass without fishing (CSA 1S). Positive change indicates that the reef or shell plant is fishable.

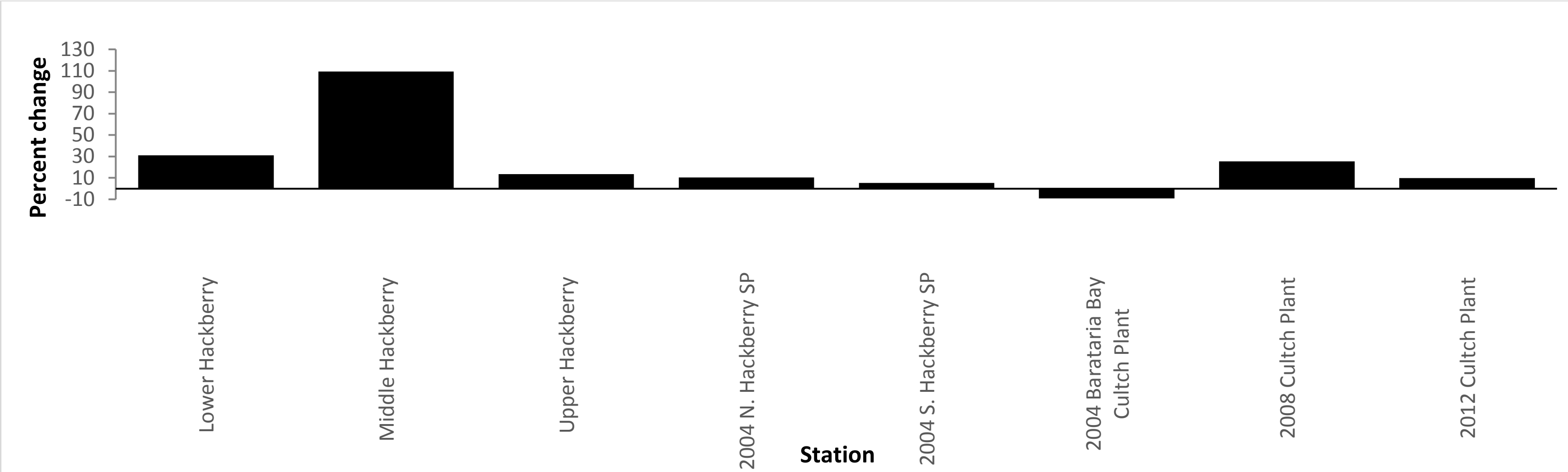

Figure 5. Initial simulations to determine percent change in cultch mass without fishing (CSA 3). Positive change indicates that the reef or shell plant (SP) is fishable.

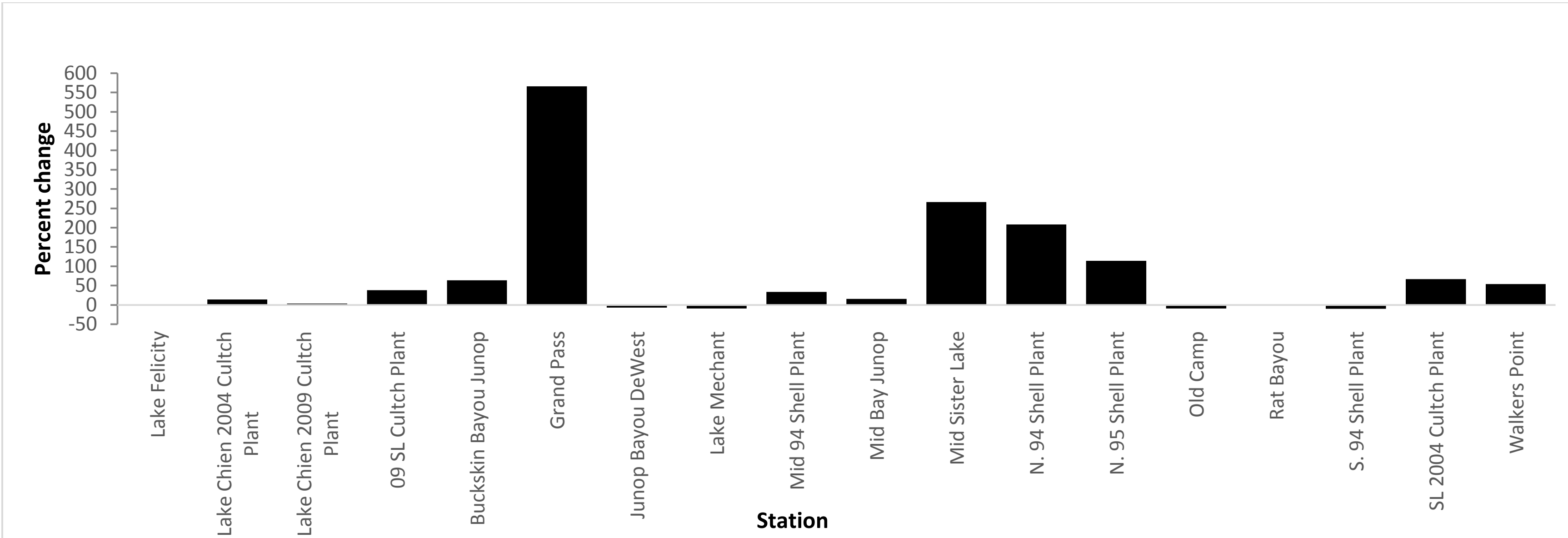

Figure 6. Initial simulations to determine percent change in cultch mass without fishing (CSA 5). Positive change indicates that the reef or shell plant is fishable.

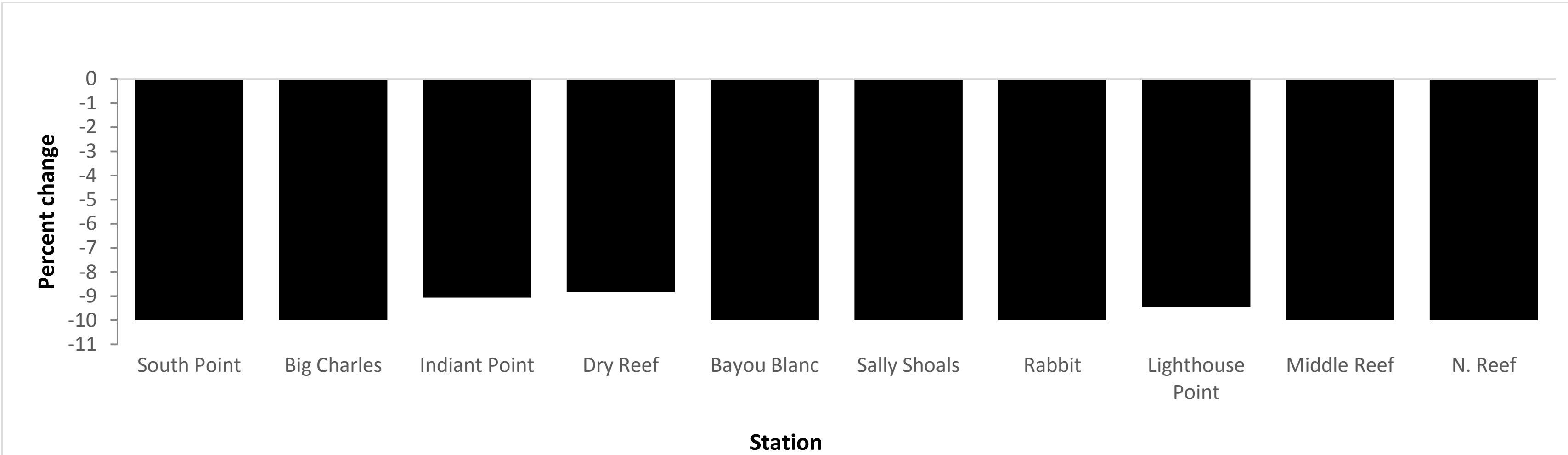

Figure 7. Initial simulations to determine percent change in cultch mass without fishing (CSA 6). Positive change indicates that the reef or shell plant is fishable. Note that none of the stations in CSA 6 are deemed fishable.

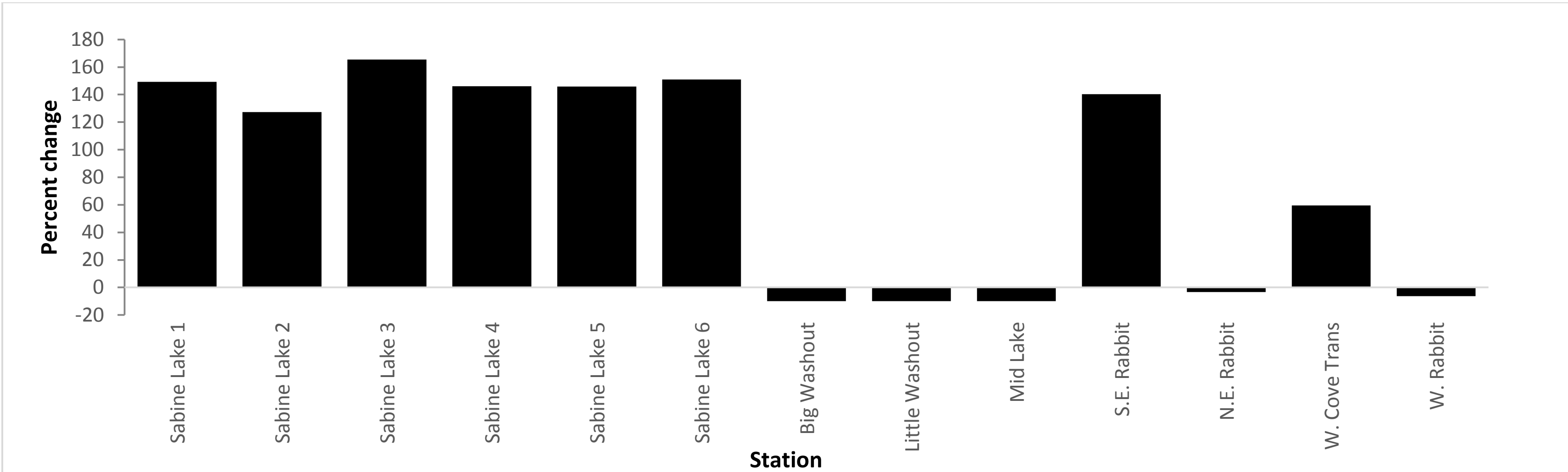

Figure 8. Initial simulations to determine percent change in cultch mass without fishing (CSA 7). Positive change indicates that the reef or shell plant is fishable.

TABLE 2.

Fishing effort by month for sack and seed oysters. Numbers are % effort expended per month as a portion of the overall effort. Data are based on anticipated fishing effort.

CSA	Effort type	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
CSA 1N	Sack Effort	0.00	0.20	0.35	0.25	0.10	0.05	0.05	0.00	0.00	0.00	0.00	0.00
	Seed Effort	0.00	0.70	0.10	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.00
CSA 1S	Sack Effort	0.00	0.20	0.30	0.20	0.10	0.05	0.05	0.10	0.00	0.00	0.00	0.00
	Seed Effort	0.00	0.70	0.10	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.00
CSA 3	Sack Effort	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Seed Effort	0.00	0.70	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSA 5E	Sack Effort	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Seed Effort	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSA 5W	Sack Effort	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Seed Effort	0.00	0.70	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSA 6	Sack Effort	0.00	0.10	0.20	0.20	0.20	0.10	0.10	0.10	0.00	0.00	0.00	0.00
	Seed Effort	0.60	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00
CSA 7	Sack Effort	0.00	0.00	0.20	0.35	0.05	0.10	0.15	0.15	0.00	0.00	0.00	0.00
	Seed Effort	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 3.

Simulated sustainable catch (sacks) for fishable and open stations. Not fished refers to a region closed to fishing. Not fishable indicates that none of the open reefs in the region support a sustainable harvest.

CSA	New CSA	Fishing Mode	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Total
1	1N	Sack	0	0	2405	3741	2205	830	382	373	0	0	0	0	9936
1	1N	Seed	0	0	4550	628	0	0	645	642	0	0	0	0	6464
2	1S	Sack	0	0	6122	3705	0	126	45	38	63	0	0	0	10098
2	1S	Seed	0	0	1101	155	0	0	160	0	0	0	0	0	1416
3	3	Sack	0	0	561	524	0	0	0	0	0	0	0	0	1085
3	3	Seed	0	0	968	381	0	0	0	0	0	0	0	0	1349
4	5E	Sack						**Not fished**							
4	5E	Seed													
5	5W	Sack	0	0	13887	11686	0	0	0	0	0	0	0	0	25573
5	5W	Seed	0	0	7529	2884	0	0	0	0	0	0	0	0	10413
6	6	Sack						**Not fishable**							
6	6	Seed													
7	7	Sack	0	0	0	6844	11042	1398	2843	4075	3868	0	0	0	30070
7	7	Seed	0	0	0	0	0	0	0	0	0	0	0	0	0
Sack Total															**76763**
Seed Total															**19642**

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